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Towards a Resilient Future: Federal Policies for Adapting the U.S. Coasts to Climate Change

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Abstract

Climate change is projected to have a devastating impact on the American coast, yet coastal communities and states have largely failed to prepare for projected impacts. This is in large part due to a lack of resources. This thesis analyzes innovative federal policy mechanisms that will address the current gap between actions and forecasted impacts, and will make U.S. coastal communities more resilient in the face of climate change.

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Table of Contents

Executive Summary……..4

Introduction……...6

Methodology…….9

Literature Review…….10

Existing Federal Funding Sources……15

State Action on Climate Resilience……..21

Deep Dive: Louisiana's Coastal Protection Efforts……..28

Policy Alternative: FEMA's Disaster Deductible…….40

Policy Alternative: NFIP Reform and CBRA Expansion……50

Policy Alternative: Resilience Tax Credits……..57

Assessment……...59

Conclusion: Final Recommendations…….…64

Works Cited…….…68

Executive Summary

Climate change is projected to impact the coasts to a greater extent than any other geographic region in the United States. Climate impacts will have significant adverse effects on coastal communities, where 40 percent of Americans live, on assets and properties, and on regional and nationwide economies. Cumulative damage will reach into the trillions of dollars. Despite these foreboding projections, localities have largely failed to prepare for new and increased vulnerabilities and states have failed to increase resilience on a larger scale and influence local actions, in large part due to lack of resources. The federal government has failed to adequately fund resilience and has contributed to inadequate standards. To prevent catastrophic losses, coastal communities must adapt to climate change and build resilience against its impacts. Although adaptation and resilience are inherently local issues dependent on a specific area's risk profile, the federal government must implement policy mechanisms that will address the gap between risk and action and enable communities to sufficiently prepare for climate change.

In order to identify policies that would achieve this goal at the federal level, this thesis looks to state-level policies to identify scalable best practices, analyzes innovative federal policy proposals, and examines existing policies that could be expanded. Based on this analysis, the following recommendations are made:

1. The President should seek Congressional approval to create a new agency dedicated to resilience, to be housed under the Department of Homeland Security (DHS). The agency should include an Office of Coastal Resilience and should consolidate existing relevant offices and funding sources. The agency should

utilize climate science to inform funding decisions. The agency should also appoint deputy administrators who concurrently hold other positions in federal departments.

2. The Federal Emergency Management Agency (FEMA) should institute stronger mandatory minimum floodplain standards based on 500-year flood standards, to be phased in over a set number of years. The NFIP should expunge policyholders who do not comply with these standards within the allotted period of time. FEMA should also follow through on the implementation of the National Flood Insurance Program's (NFIP) Risk Rating 2.0.

    a. Congress should supplement these new standards by approving resilience tax credits for low-income home and business owners enrolled in the NFIP, to alleviate financial strain and mitigate inequitable outcomes.

3. The Fish and Wildlife Service (FWS) should identify areas which may be amenable to Coastal Barrier Resources Act (CBRA) expansion.

4. FEMA should add a credit proposed Disaster Deductible that would incentivize states to adopt administrative authorities similar to the Coastal Protection and Restoration Authority in Louisiana, and should continue to refine the proposed Deductible in cooperation with Congress and state partners.

Introduction

Climate adaptive measures are not yet common in the U.S. (Bierbaum et al., 2013). Fewer than 1 percent of U.S. cities have begun to plan adaptation measures for climate change, and they have engaged with adaptation policies at a lower rate than cities in any other country (Hansen, Gregg, Arroyo, Ellsworth, Jackson, & Snover, 2013; Aylett, 2014). Despite these clear deficiencies, cities are still doing more than state and federal governments (Bierbaum et. al, 2013). A primary reason for the lack of action is funding; many localities simply do not have the resources to invest in the multi-billion dollar adaptive measures often necessitated by the scale of climate change.[1] Given the lack of state and local funding, the federal government must step up to provide coastal communities with adequate levels of funding, incentives, and other mechanisms to enhance coastal resilience to climate change. Neglecting this obligation will have catastrophic results for people, property, and regional and nationwide economies.

Anthropogenic climate change is no longer an abstract idea, but a quantifiable reality. Greenhouse gas (GHG) emissions have caused changes in Earth's climate, resulting in a number of physical impacts, including sea level rise (SLR), more frequent and intense hurricanes, and erosion. Following global trends, sea levels are projected to rise 0.5-1.2 meters in the U.S. under every emissions scenario, while Category 4 and 5 hurricanes in the Atlantic region may increase in frequency by between 45% and 87% (Kopp et al., 2014; Knutsen et al., 2013). Historically, only 15% of the hurricanes that have made landfall in the U.S. have been a Category 4 or 5, yet they have caused nearly 50% of historical hurricane damage (Pielke et al.,

[1] See literature review for a more comprehensive overview.

2008). Since 1980, tropical storms, including hurricanes, have caused 55% of billion-dollar disaster damages - the highest proportion of any disaster type (Smith, 2019). More frequent hurricanes of a high intensity will cause immense damages, putting coastal communities in danger and straining government resources. The U.S. has already seen what happens when such intense events occur in quick succession: between 2016 and 2018, the U.S. was hit by six hurricanes which caused over $1 billion in damages each, totaling nearly $330 billion in cumulative damages (Smith, 2019). Coastal flooding frequency has also increased dramatically in the U.S. due to SLR, particularly along the East and Gulf coasts. Some locations have seen coastal flooding increase by as much as ten times since 1950. (EPA, 2016).

Projections indicate that coastal communities may face the greatest physical damages from climate change (Kopp et al., 2014; Hsiang et al., 2017). Studies have shown that between $66 and $106 billion worth of coastal property will likely be below sea level by 2050 under current emissions trends, and as much as $507 billion by 2100; that rising storm surge levels due to SLR will cause an average increase of $2 to $3.5 billion in damages per year as soon as 2030; and that average annual damages from hurricanes could increase by over 50 percent to $22 billion by 2050 (Kopp et al., 2014). The Fourth National Climate Assessment projects even more dire results, with as much as $3.5 trillion in cumulative property damage in coastal counties by 2060 (U.S. Global Change Research Program, 2018).

The U.S. can reduce the extent of these projected damages through adaptation and resilience. Resilience is a framework-based approach to climate change focused on the ability to absorb shocks and bounce back to normal conditions. Adaptation is a subset of resilience which

refers to actions meant to reduce risk.[2] Sufficient adaptation could reduce cumulative property damage to $800 billion (USGCRP, 2018).

However, the cost of adaptation is often prohibitive, especially given the fact that adaptation projects can have long timescales to completion and may not become useful for a number of years. Cost estimates of national and sectoral-level adaptation are highly variable, limited in their scope, and are generally believed to be understated (Sussman et al., 2013).[3] Nonetheless, they are useful for inferring the scale of the problem. Only one publication has compiled regional and sectoral cost estimates for adaptation in the U.S. It found that expenditures for nationwide adaptation could span from tens of billions to hundreds of billions of dollars per year. In coastal areas, studies have estimated that the cumulative costs of adaptation (of varying degrees and types) by 2100 range between $43.4 billion and $1 trillion, the most recent of which estimated that sufficient sea walls, bulkheads, and beach nourishment alone would cost $210 billion (Sussman et al., 2013). However, investing in resilience produces more benefits than costs. One study found that as much as $11 were saved for every $1 invested in natural hazard mitigation strategies (NIBS, 2018). Although cost estimates for coastal adaptation are extremely variable, they point to one reality: that the cost of building resilience will be exceptionally high, but the cost of doing nothing will be even greater.

The climate impacts that have already begun and those that are projected to worsen pose a threat to the 40 percent of Americans who live in coastal communities and the $8.3 trillion in

[2] For the purposes of this thesis, the two terms will be used interchangeably.
[3] Limitations include: studies of coastal areas not including hurricane risk; the difficulty of measuring the cost of "soft" adaptation measures; uncertainty of climate impacts; the possibility of changing timelines and costs often associated with public projects; the potential for poor construction or maintenance to lead to additional costs; changes in coastal development and/or population; and different cost estimates based on the timeline of implementation.

goods and services they produce annually, in addition to nearly half of the U.S. GDP (NOAA Office for Coastal Management, 2015; USGCRP, 2019). However, many cities and states have been unable to marshal the resources necessary for building resilience. In order to preemptively prepare for climate change at a scale commensurate with projected impacts, cities, regions, and states must look to the federal government to implement policy mechanisms that will catalyze investments in adaptation, incentivize risk reduction, and above all, keep America's most vulnerable communities and economies safe from the impacts of climate change.

In this thesis, I will analyze innovative policy solutions to this problem, using precedent, case studies, and new proposals, and make recommendations on the most effective way to build U.S. coastal resilience.

Methodology

In this thesis, I have relied primarily on government documents, supplemented by interviews with leaders in the field of climate resilience. To assess state action on adaptation and resilience, I utilized climate projections to identify the states most vulnerable to coastal damages. I then relied on the Georgetown Climate Center's State Adaptation Progress Tracker to identify relevant actions on the state level. To further assess state initiatives, I examined state adaptation and resilience plans, executive orders, legislation, and other relevant documents, which enabled me to identify best practices, gaps, and innovative policy ideas. I conducted an in-depth assessment of Louisiana's coastal protection efforts due to the state's high level of risk and preparedness compared to other states. This was accomplished primarily by using relevant agency documents and plans. This was supplemented through an interview with Charles

Sutcliffe, Louisiana's Chief Resilience Officer for Coastal Activities, who provided information on the organizational structure, history, and background of the Coastal Protection and Restoration Authority. To analyze FEMA's proposed Disaster Deductible, I relied primarily on the proposal published in the Federal Register and analyzed public comments from relevant organizations and officials. To supplement this work, I interviewed the Honorable Craig Fugate, the former FEMA Administrator under whom the policy was developed. Assessment of NFIP reforms was conducted by drawing from previous proposals and critiques by relevant parties. I analyzed the CBRA by examining the act itself and using Congressional Research Service documents. Tax credits were analyzed using past analyses of similar tax credits for energy efficiency. Finally, the assessment was conducted drawing from the iterative eightfold path method developed by Bardach and Patashnik (2016).

This thesis then incorporates ideas of resilience as a systems-based framework with quantifiable outcomes, designed to build climate-resistant capacities. It will take the major barriers identified in past studies and attempt to discern, analyze, and assess potential solutions. It will differ from past works by focusing not on international development or urban resilience, but on federal measures, while taking examples from state initiatives.

Literature Review

The Origins of Resilience and Its Many Forms

Climate resilience is a relatively new concept with ancient roots. Alexander (2013) traces the etymology of "resilience" to the Roman Empire, where it was used to mean "leaping" or "rebounding." Resilience was made prominent in the environmental field by Holling (1973), who

adopted it as a measurable concept to describe ecosystems (Folke, 2006; Meerow, Newell, & Stults, 2016). Holling (1973) termed it as "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables." The concept was applied primarily to ecology, where it gained widespread usage (Neubert & Caswell, 1997; Adger, 2000). Since then, the concept of resilience has migrated to other disciplines, including economics, psychology, political science, engineering, and geography (Pendall, Foster, & Crowell, 2010; Bahadur, Ibrahim, & Tanner, 2013; Matyas & Pelling, 2014).

In the past 15 years, ideas of resilience have moved past Hollins's use of it as a measurable concept and more towards "a way of thinking" (Meerow, Newell, & Stults, 2016). Although Timmerman (1981) was one of the first to link resilience and climate change, only in the past decade has the intersection of the two become mainstreamed (Alexander, 2013; Taşan-Kok, Stead, & Lu, 2013). Resilience has also moved from a descriptive concept to a systems-based approach (Walker and Salt, 2012; Haimes, 2009; Fiskel, 2017). Consequently, resilience has morphed from a quantifiable ecological concept, to a systems-based framework, to a compound of both. As governments, companies, and communities prepare for the impacts of climate change, measuring their resilience has become more important, albeit more difficult (Doherty, Klima, & Hellmann, 2016; Quinlan, Berbés-Blázquez, Haider, & Peterson, 2015; Schipper & Langston, 2015; Bahadur, Lovell, Wilkinson, & Tanner, 2015; Winderl, 2014; Mayunga, 2007; Summers, Harwell, Smith, & Buck, 2018).

The importance of measuring the costs and benefits of resilient infrastructure has also increased, with Yohe, Neumann, Marshall, & Ameden (1996) and Fankhauser (1995) providing

the foundational studies on the matter. Mendelsohn (2000) established the concept of "efficient adaptation" to guide resilience and adaptation policy through a behavioral lens. However, there is still scholarly disagreement on the exact definition of resilience (Aldunce, Beilin, Handmer, & Howden, 2014). Campanella (2008) describes it as "the capacity of a city to rebound from destruction," while many government entities define it as the ability to bounce back to "normal" conditions (Davoudi et al., 2012). This definition has been critiqued, however, due to the potential undesirability of past normalcy, for example in pre- and post-Katrina New Orleans (Pendall, Foster, and Cowell, 2010). Despite this definitional and operational ambiguity, resilience has become an important guiding concept in efforts to combat climate change. As Mitchell (2013) said, "everyone is talking about resilience."

Research on Barriers and Incentives for Resilience

The subject of barriers and incentives for climate resilience is, like the broader concept, relatively new. There are limited academic studies on the topic which are augmented by a handful of government (both international and national/subnational) and non-governmental publications. The literature on barriers and incentives can be broadly split into two categories: international finance and development, and urban resilience.

Bouwer and Aerts (2006) presented an early study on the challenges of financing resilience at an international scale, with proposals to ameliorate the problem through both the UNFCCC and generalized international development efforts. Other scholars continued in this vein, studying how international financing, primarily through the UN, could be applied to adaptation in developing countries (Fenton, Gallagher, Wright, Huq, & Nyandiga, 2014; Ayers and Huq, 2009; Mitchell, van Aalst, & Villanueva, 2010). Burton (2009) described the

"adaptation deficit," or the idea that resilience and adaptation measures have not increased with or been mainstreamed into international development, contributing to less economically developed nations having less adaptive measures. Barriers and strategies for increasing resilience in specific less economically developed countries, primarily island nations in Asia, have also been a focus (Am, Cuccillato, Nkem, & Chevillard, 2013; Ayers, Huq, Wright, Faisal, & Hussain, 2013; Pervin, 2013; Ayers, Kaur, & Anderson, 2011).

Adaptation and resilience specific to urban settings has been a primary research area (Tyler & Moench, 2012; Bahadur & Tanner, 2014; Satterthwaite, 2013; Jha, Miner, & Stanton-Geddes, 2013; Surjan, Sharma, & Shaw, 2011; Hughes, 2015). Some authors have worked at the intersection of international development and urban resilience, focusing on how the former can specifically help urban areas build resilience (Bulkeley & Tuts, 2013; Baker, 2012). Giordano (2012) wrote one of the few non-spatially-based pieces, focusing instead on the importance of incorporating climate resilience into the infrastructure planning process: he concluded that governments are crucial to implementing adaptive, climate-aware planning processes into the design of long-lived infrastructure. Brugmann (2012) focused specifically on strategies to upscale financing for adaptation in cities. Cheong (2010) completed one of the few studies focused on specific solutions, writing about relocation, zoning, insurance, and subsidies, and finding that a "strong state" would likely increase the effectiveness of such measures.

Some of the literature on barriers to resilience has been conceptual or framework-oriented (Adger et. al, 2009; Moser & Ekstrom, 2010). Others have been more empirical, such as Bierbaum et. al (2013), who found that "few [adaptation] measures have been implemented [in

the U.S.] and even fewer have been evaluated...the most significant barriers include lack of funding, policy and institutional constraints, and difficulty in anticipating climate change…"

Funding has been identified as a significant barrier to resilience and adaptation in multiple studies (Brunner & Nordgren, 2012; Carmin, Nadkarni, & Rhie, 2012; Garfin, Jardine, Merideth, Black, & LeRoy, 2011; Lackstrom et. al, 2012; Shi et. al, 2016; McIntosh & Cone, 2014; Nordgren, Stults, & Meerow, 2016; Ekstrom & Moser, 2014). Wheeler (2008) found that most local climate action plans do not identify both specific funding needs or potential funding sources. Furthermore, the study found that local governments have often been unwilling to use their own budgets to fund climate change programs. This observation built on findings from Bailey (2007), who noted that cities were not investing their own funds in greenhouse gas reduction programs. Aylett (2014) found that U.S. cities have the lowest rate of engagement with adaptation policy relative to other nations. Similarly, fewer than 1 percent of U.S. cities have begun to plan for climate adaptation (Hansen, Gregg, Arroyo, Ellsworth, Jackson, & Snover, 2013). Yet, Bierbaum et al. (2013) also found that U.S. local governments have engaged in adaptation to a greater extent than state or federal governments. Morsch and Bartlett (2011) provided an overview of the few state strategies for climate adaptation.

Existing Federal Funding Sources

There are a number of extant federal funding sources for projects focused on climate resilience, most of which are in the form of grant programs. However, it is difficult to comprehensively provide an overview of existing programs: a Government Accountability

Office (GAO) report found that federal climate programs are fragmented, often serve multiple purposes, and are not reported on in great detail by the Office of Management and Budget (GAO, 2018). Nonetheless, estimated funding levels can be roughly estimated and prevailing themes can be identified. This following analysis identifies a number of issues with current federal funding sources. First and foremost, there is simply not enough money available. Furthermore, FEMA grants, which make up a significant portion of resilience-related grants, have been plagued by a lack of transparency in the selection process (H.Rept 115-107, 2017; Interview with Charles Sutcliffe, November 6, 2019). Many funding sources cap disbursements at relatively small amounts. Others are restricted to specific geographic areas, often in response to specific disasters. Lastly, many grant programs are decided by congressional appropriations and fluctuate annually, leaving important coastal resilience funds dependent on political decision making.

The following section will discuss the main sources of federal funding for resilience that can be applied to coastal communities. The primary target of some of the following programs is not resilience or adaptation, but they have been or may be applied for those uses.

There are a number of relevant grant programs housed in DHS, exclusively within FEMA. FEMA's Hazard Mitigation Grant Program (HMGP) provides post-disaster assistance for communities to reduce future disaster damages. Funding is available for state, local, tribal, and territorial (SLTT) entities following a federally-declared disaster. FEMA provides funding up to 75 percent of project costs. However, the total amount of funding available is contingent on the projected dollar amount of federal assistance following a disaster declaration. HMGP funding for a project is capped at up to 15 percent of the first $2 billion of estimated disaster assistance, up to 10 percent for assistance between $2 billion and $10 billion, and up to 7.5 percent for

assistance between $10 billion and $35.333 billion (FEMA, 2019h). In Fiscal Year 2018 (FY18), slightly more than $826 million in grants were given out through the HMGP (DHS, 2019). However, estimated project funding for FY19 has decreased sharply to $601 million (U.S. System for Award Management, 2019). HMGP funds are appropriated by Congress during the budgeting process.

FEMA's Pre-Disaster Mitigation (PDM) Program provides grants to SLTT entities in order to implement projects that reduce the cost and damage of future disasters. In FY19, PDM has a total funding pool of $250 million, with $20 million allotted to tribal applicants (FEMA, 2019b). This is a notable increase from FY15, when PDM was appropriated only $25 million (FEMA, 2019a). However, funds are limited based on project type. The two most relevant project types, Hazard Mitigation and Resilient Infrastructure, are capped at $4 million and $10 million per project, respectively (FEMA, 2019c). PDM can only fund up to 75 percent of a project's costs (FEMA, 2019c). PDM funds, like the HMGP, are appropriated by Congress.

FEMA's Mitigation Assistance (FMA) Program is specifically for projects that will reduce future damages to structures covered by the NFIP (FEMA, 2019d). Funding may also be used to devise flood mitigation plans. Individual homeowners are able to apply for funding, provided they are sponsored by a SLTT entity. In FY19, FMA has been appropriated $160 million, with a maximum of $10 million available for community flood mitigation projects (FEMA, 2019d). FMA will generally fund only up to 75 percent of a project. (FEMA, 2019d). FMA funding has decreased slightly since FY16, when it was appropriated nearly $200 million (FEMA, 2016). FMA funding is appropriated by Congress.

FEMA's Building Resilient Infrastructure and Communities (BRIC) program is new as of 2019 and is still in the implementation stage. Although few details of the new program have been made publicly available, BRIC will provide grants to SLTT entities for hazard mitigation and large-scale resilient infrastructure projects (Fox, 2019). BRIC will differ from FEMA's other grant programs in that funding will be derived from the Disaster Relief Fund (DRF). The DRF has been used primarily to respond to and rebuild after disasters, not to build resilience. FEMA recently announced that BRIC grants will be funded by a 6 percent set-aside from the estimated cost of disaster recovery for the specific disaster to which a grantee is responding. FEMA has indicated that this will come at the expense of PDM and DRF funding (DHS, 2019).

The Department of Housing and Urban Development (HUD)'s Community Development Block Grant Disaster Recovery (CDBG-DR) Program is available to states, counties, and cities following a federal disaster declaration, and provides funding for unmet needs relating to disaster relief, long-term recovery, revitalization, and restoration. Since the program began in 1992, it has provided nearly $90 billion in grants (HUD, 2019a). CDBG-DR does not have annually appropriated funds: it is funded by congressional appropriations in response to a specific event(s) (HUD, 2019b). Adaptation or resilience projects must be part of the rebuilding process in order to be eligible for CDBG-DR funding (HUD, 2019b).

Following Superstorm Sandy in 2013, HUD launched the Rebuild by Design competition along with philanthropic, academic, and non-profit partners. Funding was intended to spur innovative projects that would build resilience and could be scaled up regionally. The competition awarded $930 million in funding, which was derived from CDBG-DR funds

specifically appropriated to communities impacted by Sandy (HUD, 2019c). It is not clear if Rebuild by Design will have another application round or apply to states not affected by Sandy. Similarly to Rebuild by Design, HUD's National Disaster Resilience Competition draws funding from CDBG-DR. Funding was applicable for states, counties, and cities that had experienced major disasters in 2011, 2012, or 2013. A total of 13 projects have been funded, totaling nearly $1 billion (HUD, 2019d). It is not clear if future funding opportunities will be available.

In the Department of Commerce, the National Oceanographic and Atmospheric Agency (NOAA) and National Fish and Wildlife Foundation (NFWF) jointly administer the National Coastal Resilience Fund, which was launched in 2018 as a public-private partnership between NOAA, the NFWF, Shell Oil Company, and TransRe (NFWF, 2018). It awarded nearly $29 million in grants to 35 projects its inaugural year. The fund applies to projects which build resilience in coastal communities, improve water quality in coastal communities, or enhance coastal ecosystems (NFWF, 2019).

Within the Department of the Interior, the United States Fish and Wildlife Service (FWS) National Coastal Wetland Conservation Grant, which is provided to states in order to restore or enhance coastal wetlands and adjacent habitats. While this program does not specifically target resilience, projects that are awarded funding may, and often do, focus on resilience and adaptation. Funding is capped at $1 million per project (FWS, 2019a). In 2019, the program awarded slightly more than $20 million to 22 projects, five of which specifically mentioned resilience (FWS, 2019b).

The United States Army Corps of Engineers (USACE), which is housed under the Department of Defense, administers the Continuing Authorities Program (CAP). CAP provides

assistance with feasibility studies and implementation of projects with water-based resilience benefits. The amount of funding provided for implementation is project-specific (USACE, 2019).

The Department of Transportation (DOT) houses two relevant grant programs. The Build America Bureau and Better Utilizing Investments to Leverage Development (BUILD) program provides grants, loans, technical expertise, and credit for large-scale infrastructure projects (DOT, 2019a). These resources may be used for resilient infrastructure (Keenan, 2019). BUILD grants support road, rail, and port infrastructure with regional and/or national significance. In FY18, DOT awarded $1.5 billion in BUILD grants (DOT, 2019b). BUILD grants may be used to support adaptation and resilience goals, including retrofits and redundancy (Keenan, 2019).

Federal Transit Administration (FTA) Grants, the second relevant DOT program, provides grants to improve public transit systems. Grant awardees may use FTA funds to implement adaptive measures and increase the resilience of public transit systems (Keenan, 2019).

Summary

This list may not be comprehensive: there are countless federal grant programs, many of which may be applied to projects concerning resilience and adaptation. However, the programs listed represent those recognized by scholars and policymakers to be the largest and most frequent sources of funding which may be applied to coastal resilience. It is difficult to accurately quantify the sum of federal funding for adaptation from the above sources, especially given that the main purpose of some is not resilience, that not all have reported funding totals for the most recent fiscal year, and that some are relevant only to specific events. Nonetheless, the

funding levels reported show that the federal government is likely awarding upwards of $3 to $4 billion, but fewer than $10 billion, to projects focused on adaptation and resilience in a given year. While this is a significant sum, it is not enough to support adequate levels of coastal adaptation and resilience. Furthermore, many of these grants have their own shortcomings. Some are tied to specific disasters, making them inaccessible to other communities that are nonetheless in need of funding for resilience. Many are contingent on congressional appropriations, causing funding levels to potentially fluctuate annually, and leaving coastal resilience hanging in the balance of politically-charged decision making. Many of these grant programs also cap funding at relatively low amounts. Impactful projects requiring large investments – from tens of millions to billions of dollars – would be hard pressed to find adequate funding sources from among these federal programs, many of which cap project funding below $10 million. Lastly, because grants for coastal resilience are fragmented among numerous agencies and departments, they require considerable time, effort, and expertise on the part localities to sift through and apply for them. Though these programs represent a start for making coastal communities more resilient against the impacts of climate change, there is neither enough funding available nor sufficient coordination to adequately adapt the U.S. coast.

State Action on Climate Resilience: A Brief Overview

In order to assess both adaptation needs and potential scalable solutions, a series of states were investigated. States were selected based on cumulative projected coastal damage. The data used calculated damage as change in damage from coastal storms as a percent of county-level

GDP. Of the states projected to have increases in damages, those with significant projected damages were: Texas, Louisiana, Florida, South Carolina, North Carolina, Maryland, Delaware, New Jersey, Rhode Island, Connecticut, New York, and Massachusetts (Hsiang et al., 2017).[4] In order to assess the state of coastal adaptation and resilience funding in the most vulnerable states, the following section will provide a brief overview of actions, funding levels, and unique or innovative policies, if applicable, drawing primarily from the Georgetown Climate Center's State Adaptation Progress Tracker.

Louisiana was determined to be the state with both high risk and the highest level of coastal resilience action. For this reason, it was selected for an in-depth analysis of adaptation and resilience funding mechanisms and best practices, and was excluded from the following section.

Texas has developed two coastal resilience master plans, one in 2017, and one in 2019 (Adaptation Clearinghouse, 2019). The most recent one, which outlines 123 high-priority projects with a total cost of $5.3 billion, contains no mention of they are to be funded, though it does mention GOMESA as a potential source (GLO, 2019). A 2017 document from the Texas Legislative Budget Board presented three potential options: funds appropriated by the state legislature, amend dedicated revenue accounts to include coastal protection, and/or allocate a portion of the state hotel occupancy tax revenue collected in 18 coastal counties towards master plan projects (Legislative Budget Board, 2019). It is unclear both how much money any of these options would amount to and if any of these proposals have moved forward. Texas voters approved Proposition 8 in November 2019, which amended the state constitution to create an

[4] The study excluded Alaska.

$800 million flood infrastructure fund (Samuels, 2019). It is unclear whether the new fund may be used towards the coastal resilience master plan. Texas is making progress, but is clearly still in the early stages of its coastal protection build up.

Florida's adaptation and resilience planning is extremely limited, despite its high level of risk. The state released the Energy and Climate Action Plan in 2008 as, among other things, a framework from which to build future resilience efforts. There has yet to be any follow-up plan, in large part due to political opposition. In 2011, the Florida legislature passed a bill which abolished the Florida Energy and Climate Committee, which had authored the report. There has been no statewide adaptation or resilience effort since 2008, and most related activities are accomplished on the local level exclusively (Georgetown Climate Center, 2018). However, Governor DeSantis hired the state's first ever Chief Resilience Officer in August, 2019 (Florida Governor's Office, 2019).

Like Florida, South Carolina has significant vulnerabilities yet has taken little action. The Department of Health and Environmental Control published "Adapting to Shoreline Change: A Foundation for Improved Management and Planning in South Carolina," in 2010 (South Carolina Department of Health and Environmental Control, 2010). The document dealt primarily with ecological shoreline changes, but did address risk to beachfront communities. Though no specific projects were proposed, a number of policies were suggested. These proposals included preventing the seaward expansion of beachfront development, eliminating subsidies in hazardous areas, and the strategic acquisition of beachfront property. However, there appears to be no follow-up document or indication as to whether they were adopted or not. Though South

Carolina has taken initial steps towards becoming more resilient, it has yet to identify specific projects or the funding sources that would be needed to implement them.

North Carolina does not have a statewide adaptation or resilience plan. In 2012, the state convened a group of eleven state and federal agencies, including USACE but somewhat strangely excluding FEMA, to produce a framework for building resilience (North Carolina Interagency Leadership Team, 2012). The framework proposed broad goals rather than specific projects, and identified no potential funding sources. Progress since then has been nonexistent. However, Governor Roy Cooper signed Executive Order 80 in 2018, creating the North Carolina Climate Change Interagency Council and requiring them to produce a risk assessment and resilience plan by 2020 (Adaptation Clearinghouse, 2019b). Though it remains to be seen how recommended projects will be funded, North Carolina appears to be on the right track.

Virginia has taken a number of steps to elevate the issue of coastal resilience. In 2016, legislation to create a revolving loan fund for shoreline resilience was passed. The fund assists localities that experienced recurring floods. While advocates have called for $50 million to be appropriated towards the fund, it has yet to be funded (Lightbody, 2019). In 2018, S. 265 was passed, which created an executive branch position of Special Assistant to the Governor for Coastal Adaptation and Protection (Adaptation Clearinghouse, 2019c). That same year, Governor Ralph Northam signed Executive Order (E.O.) 24, which named the Secretary of Natural Resources as the state's Chief Resilience Officer and directed them to create a coastal resilience master plan. The E.O. specified that the plan should include a detailed funding analysis and recommendations for potential funding sources (E.O. 24, 2018). In November 2019, Governor Northam signed E.O. 45, which establishes a Flood Risk Management Standard meant

to discourage building in high-risk areas and encourage building elevation and other retrofits, based on climate projects (Virginia Secretary of Natural Resources, 2019). Virginia is following in the steps of Louisiana, but how much funding they can secure remains to be seen.

Maryland has released two adaptation plans, the most recent coming in 2011. Only one focused on coastal adaptation. Like many other states, it functioned more as a framework than a plan with specific projects and funding requirements. The state has also implemented "Coast Smart" building, siting, and design requirements (Georgetown Climate Center, 2018).

In 2013, Delaware Governor Jack Markell signed Executive Order 41 to establish the Cabinet Committee on Climate and Resiliency (CCoCAR). The Committee produced a framework which dealt mainly with state agencies and their related functions rather than the state or general public as a whole (CCoCAR, 2014). In 2013, the state released a plan pertaining to sea level rise adaptation. The plan laid out seven objectives, each with a number of sub-recommendations. Notably, Recommendation 7.1 suggests creating a panel of experts to assess funding options for adaptation (Sea Level Rise Advisory Committee, 2013). However, it does not appear that such a panel has been convened at this time. Like many other states in this compilation, Delaware has taken some steps towards becoming more resilient, but seems to have not yet funded large-scale adaptation efforts.

New Jersey is one of the states most vulnerable to coastal climate impacts. In 2009, the New Jersey Department of Environmental Protection recommended that the state complete a climate adaptation plan (Georgetown Climate Center, 2018). In spite of these two facts, the state has yet to develop such a plan. There has been more action on the agency and local level. For

example, the Port Authority of New York and New Jersey developed and adopted the Climate Resilience Design Guidelines to prepare agency infrastructure for future climate impacts (ibid.).

New York has a substantial number of adaptation and resilience related activities, both predating and following Superstorm Sandy. In 2011, the New York State Energy Research and Development Authority produced a report on adaptation across the state, which detailed potential adaptive measures across eight sectors, including coastal areas. However, the report did not contain cost estimates, specific projects, or potential funding sources (NYSERDA, 2011). Following Superstorm Sandy, Governor Andrew Cuomo created the 2100 Commission, which released a report on improving infrastructure resilience. Governor Cuomo also signed the Community Risk and Resilience Act in 2014, which mandated that state permitting and funding programs take climate change impacts into account (Georgetown Climate Center, 2018). New York has completed extensive research on best practices for increasing state resilience. However, it is unclear how much of these practices have been implemented. It appears that, although the state is prepared to build resilience, it has yet to do so on a large scale.

Rhode Island began planning for resilience in 2010, when the state legislature created the Rhode Island Climate Change Commission. In 2014, Governor Lincoln Chafee established the Rhode Island Executive Climate Change Council by executive order. Both groups were charged with identifying adaptation strategies (Georgetown Climate Center, 2018). In 2017, Governor Gina Raimondo established a state Chief Resilience Officer through executive order. In 2018, the state released the Resilient Rhody plan, which outlined a number of adaptation and resilience strategies and included a section on financing resilience. This section detailed barriers and potential funding options. Barriers included the limited available funding and complexity of

federal grants and lack of long-term revenue streams. Potential innovative funding options included various bond types, resilience zones where an additional tax is levied on resident to directly fund resilience initiatives, and a credit trading market (State of Rhode Island, 2018). Rhode Island clearly has an innovative vision on how to fund coastal resilience. Which methods they choose and how effective they are at mobilizing funds remains to be seen.

In 2008, Connecticut's Public Act 08-98 established an Adaptation Subcommittee within the already extant Governor's Steering Committee on Climate Change (GSC) (Georgetown Climate Center, 2018). Following Tropical Storm Irene, Governor Dannel Malloy convened the Two Storm Panel to deliver recommendations on how to increase the state's resilience (Two Storm Panel, 2012). In 2013, the Shoreline Preservation Task Force, which was created by the state legislature, produced a report detailing a number of recommendations to increase coastal resilience. There was no mention of funding sources throughout the document (Shoreline Preservation Task Force, 2013). Also in 2013, Connecticut released their statewide adaptation plan. Though it laid out a number of strategies, there were few mentions of specific funding streams (GSC, 2013). Though Connecticut has made significant strides towards identifying strategies to build resilience, it has yet to discuss or identify the necessary funding sources.

In 2008, the Massachusetts legislature passed S.2540, which, among other things, established the Adaptation Advisory Committee under the purview of the Secretary of Energy and Environmental Affairs (Georgetown Climate Center, 2018). The Committee released an adaptation report in 2011 which included a subsection on coastal resilience. This section included recommendations related to building codes, zoning, voluntary land acquisition, and the incorporation of climate projections into public infrastructure projects. However, no specific

funding sources were considered (Adaptation Advisory Committee, 2011). The state released a second adaptation plan in 2018. For each goal, the plan presents a potential funding source. However, no amounts are delineated (Massachusetts Governor's Office, 2018). Massachusetts also has a number of grant programs for resilience. In 2014, Governor Deval Patrick appropriated $10 million for coastal resilience infrastructure. In 2018, H.4835 passed, providing $501 million for coastal adaptation and resilience. Of this, $290 million was improvements and repairs to dams, seawalls, and other forms of coastal resilience infrastructure; $75 million was for local grants; and $100 million was for implementation of the most recent adaptation plan (Georgetown Climate Center, 2018). Massachusetts is one of the few states to have invested a significant sum of money in coastal resilience.

Summary of Trends

The survey of the states most vulnerable to coastal climate-induced damages reveals a number of trends. Five of the twelve states, North Carolina, Virginia, Delaware, New York, and Rhode Island, codified a form of action on resilience through executive orders. These actions were primarily confined to the establishment of committees, high-level positions, or reports. These may have been done through executive order due to opposition in the legislature. While these executive actions represent positive progress, their lack of codification leaves them vulnerable to repeal by future governors.

Another commonality is that many states have completed adaptation plans or frameworks, but have yet to translate them into specific projects, identify funding sources, or move towards implementation. This is true to varying extents for Texas, Florida, South Carolina,

North Carolina, Maryland, Delaware, New York, Connecticut, and Massachusetts. Even well-developed plans often have little if any mention of funding sources. This may indicate that states have thus far been unable to identify the necessary funding sources for implementation. It may also indicate that politicians and administrations have short-term planning and prioritization horizons, and have therefore been unable or unwilling to appropriate funds towards initiatives that will not have noticeable effects for years to come.

Some states have elevated the issue of resilience by appointing statewide chief resilience officers. Florida, Virginia, and Rhode Island have created such a position. Virginia has distinguished itself from the other two states by having an executive branch position on coastal resilience, in addition to having a chief resilience officer. Similarly, many states have recognized the importance of focusing on coastal resilience specifically by convening task forces, committees, and by dedicating sections of reports to it. It is clear, however, that appointing a chief resilience officer is an emerging best practice (ecoRI, 2017). Creating a position or an authority specifically for coastal resilience may be an even more effective way to focus on America's most at-risk areas.

Deep Dive: Louisiana's Coastal Protection Efforts

Louisiana has had, at the time of this writing, an unparalleled history of significant natural disasters. Hurricane Katrina stands out for its severity: at least 1,800 people died, 1.3 million were forced to evacuate, and New Orleans has yet to fully recover (Lopez, 2015). Yet, natural disasters have long been endemic to Louisiana. This history of storms, land loss, and

destruction is more extreme than is the case in most other states. It has made Louisiana acutely aware of the challenges it faces and the actions it must take to become more resilient. Due to this longstanding history of natural disasters, Louisiana has been a leader in funding and organizational initiatives relating to climate adaptation and resilience. It has also implemented unique and innovative resilience policies, particularly since Hurricane Katrina in 2005.

Louisiana's Risk Profile: Current and Cumulative Impacts

Louisiana faces some of the most dire consequences of coastal climate impacts. Since 1932, the state has lost more than 1,900 square miles of coastline – an amount nearly equal to the state of Delaware – due in large part to SLR, storm surges, and hurricanes (LA OCD, 2019). Of those roughly 1,900 square miles lost, 300 square miles disappeared between 2004 and 2008 solely because of Hurricanes Katrina, Rita, Gustav, and Ike (CPRA, 2017). The destruction of barrier islands has further exacerbated land loss, as the storm surge attenuation they provided is no longer present in many areas (Union of Concerned Scientists, 2018). Louisiana is the most flood-prone state in the U.S, and every single parish in the state has been included in a federal disaster declaration since 2005 (LA OCD, 2019). Current annual flooding damages along the coast are roughly $2.4 billion (CPRA, 2017).

Louisiana's Risk Profile: Future Projections and Implications

Though Louisiana's coast has already felt many impacts from climate change, future projections are even more foreboding. Relative SLR is projected to range between two and six feet in coastal Louisiana by 2067, depending on local geography (LA OCD, 2019). As sea levels rise, flooding will become deeper and more frequent, causing current protective measures to fail,

some sooner than later. The Hurricane and Storm Damage Risk Reduction System (HSDRRS), a series of levees, pumps, and other protective measures built in the aftermath of Hurricane Katrina at a cost of $14 billion, will no longer provide adequate protection against 100-year storm events by 2023, due in large part to SLR (USACE, 2019). Without adequate action, *annual* damages from flooding alone could be as high as $21 billion by 2061 (RAND, 2012). Increased sea levels, along with coastal erosion exacerbated by barrier island loss, will cause the state to lose as much as 2,254 square miles of land in the next 50 years (LA OCD, 2019). This land loss will only further exacerbate coastal flooding. The intensity of storms impacting Louisiana could also increase by as much as 15 percent (LA OCD, 2019).

Future climate impacts along the Louisiana coastline will harm both local communities and the entire U.S. Over two million people live along the Louisiana coastline, many of whom live in impoverished, majority-minority communities (CPRA, 2017b; Union of Concerned Scientists, 2018). Should land loss continue without sufficient mitigation, the cost to relocate those most vulnerable to climate change will be upwards of $40 billion – much of which will be concentrated in Louisiana (CPRA, 2017b). Using a different SLR model than CPRA, one study found that 45,000 properties in Louisiana, which are currently home to 99,000 people and are worth $4.3 billion, will be chronically inundated by 2045. These properties currently supply $36 million in property tax revenue annually (Union of Concerned Scientists, 2018b). Coastal climate impacts will not only uproot thousands of people and harm local economies, but will also impact local government budgets. This may further inhibit the ability of localities to budget for climate adaptation.

Many pieces of nationally significant infrastructure are at risk as well. These include New Orleans International Airport, the New Orleans Naval Air Station Joint Reserve Base, and the Port of South Louisiana, which is the country's largest port by tonnage (Brennan et al., 2008; LA OCD, 2019). Large offshore oil and natural gas operations and distribution infrastructure are also at risk: a three-week disruption in service to Port Fourchon, a hub for oil import and distribution, would cost the U.S. economy $3.1 billion in earnings and over 65,000 jobs (LA OCD, 2019).

Agency Consolidation: The CPRA

Prior to Hurricane Katrina, Louisiana had a number of agencies dedicated to coastal protection. However, this produced a situation in which efforts to address coastal issues were "inadequate, fragmented, [and] uncoordinated" (S.71, 2005). Following Hurricanes Katrina and Rita, the federal government conditioned funding for studies on hurricane protection measures on the establishment of a single state entity with oversight over flood and hurricane resilience projects (Public Law 109-148, 2005). Following this ultimatum, the Louisiana legislature created the Coastal Protection and Restoration Authority (CPRA) as an entity within the Governor's office. CPRA was given oversight of hurricane protection and coastal restoration projects through the combination of levee protection and wetland restoration departments, which had previously been separate (Interview with Charles Sutcliffe, November 6, 2019). CPRA was also given a mandate of creating a coastal master plan every five years. In 2009, the Louisiana legislature created the Office of Coastal Protection and Restoration (OCPR) as the implementation arm of CPRA. In 2012, the original CPRA was renamed the CPRA Board, and OCPR was renamed as the CPRA. Currently, the CPRA serves as the sole state entity which develops, implements, and enforces coastal protection projects, and coordinates with local, state,

and federal partners to do so (CPRA, 2019). The CPRA also has its own finance corporation, the CPR FC, but little information is publicly available on it. The CPR FC has the ability to issue bonds to finance projects, though it has yet to do so (EDF, 2018).

Funding Louisiana's Coastal Protection

Revenue: Polluters Pay

CPRA generates a large amount of revenue from a number of different sources. In FY20, CPRA projects revenues of $813 million and expenditures of $747 million. Both revenues and expenditures are projected to increase over time, though the gap between the two will shrink. In FY22, CPRA projects revenues of $1.005 billion but expenditures of $1.047 billion: a $42.5 million deficit (CPRA, 2019b). The projected increase in revenue is driven primarily by funds from the 2010 *Deepwater Horizon* settlement.

The *Deepwater Horizon* funds come from three specific sources. One source is a Natural Resources Damage Assessment (NRDA), a legal process established by the 1990 Oil Pollution Act. An NRDA, which is most often completed by NOAA or the U.S. EPA, assesses the amount of damage caused and an appropriate settlement amount needed to restore damaged natural resources (Burlington, Meade, Baker, Brosnan, and Helm, 2010). In the case of *Deepwater Horizon's* NRDA, BP will pay a total of $5 billion to Louisiana, disbursed in annual segments from 2017 to 2031, most of which will be appropriated towards coastal habitat restoration, conservation, and protection (Kline, 2017). NRDA funds available to CPRA will increase from $95 million in FY20 to $372 million in FY22 (CPRA, 2019b).

The second source is the NFWF's Gulf Environmental Benefit Fund (GEBF). The GEBF was established during the litigation process as part of BP's settlement. BP and Transocean paid

a total of $2.54 billion to the GEBF, which will be used to support natural resource projects in affected states (NFWF, 2018). Louisiana was budgeted nearly $1.3 billion from the GEBF funding pool, which is distributed as grants to specific projects, exclusively ones related to barrier islands and river diversion (CPRA, 2017). CPRA expects $157 million from NFWF in FY20, but only $52 million by FY22 (CPRA, 2019b).

The third *Deepwater Horizon* funding source is revenues from the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (RESTORE Act). The RESTORE Act established a Gulf Coast Restoration Trust Fund where 80% of civil penalties paid under the Clean Water Act are deposited (USDT, 2019). The trust fund has roughly $5.36 billion, of which approximately $854.6 million has or will be sent to CPRA (Kline, 2017). Funds can be allocated towards resilience projects, ecosystem restoration, and spill cleanup. In FY20, CPRA expects $89 million from RESTORE funds; this is projected to rise significantly to $275 million in FY22 (CPRA, 2019b).

Revenue: Other Major Sources

Although funds related to the *Deepwater Horizon* settlement make up over 40 percent of CPRA funding, there are several other significant funding sources. In FY20, the largest of these is funding derived from the state budget surplus. Surpluses from 2007, 2008, 2009, and 2018 collectively contributed $138 million to CPRA revenues in FY20 (CPRA, 2019b). Budget surpluses may be allocated to CPRA or CPRA's trust fund by the legislature or the governor.

The 2006 Gulf of Mexico Energy Security Act (GOMESA) provides another large revenue stream for CPRA. GOMESA distributes 37.5 percent of revenue collected by the federal government from oil and gas leasing activities in the Gulf of Mexico. This fund is then

distributed to Alabama, Louisiana, Mississippi and Texas, though since 2017, there has been a $500 million cap on revenue sharing (BOEM, 2019). Although GOMESA revenue ultimately depends on the oil and gas market, Louisiana is apportioned nearly half of annual GOMESA revenue, of which roughly 80 percent is given to CPRA (Kline, 2017). In FYs 20 through 22, CPRA projects GOMESA revenues of $70 million each year. CPRA also has funding from surplus GOMESA revenue: it appears that revenue exceeded projections in certain years, leading to unused funds which rolled over into the current FY. In FY20, carried-forward GOMESA revenue totaled $114 million (CPRA, 2019b).

A third major funding source is the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA). CWPPRA was established in 1990 through the Breaux Act, and channels funding to CPRA from NOAA, USACE, EPA, FWS, and the USDA to pay for coastal restoration projects that will protect the Louisiana coast from storm surge and other flooding events. These agencies provide 85 percent of funds for specific projects, with state funding providing the remaining 15 percent (Restore the Mississippi River Delta, 2017). CWPPRA federal funds are derived from taxes on fishing and boating equipment. CWPPRA is only authorized through FY19, while funds will be available through FY21 (Kline, 2017). However, CPRA expects to receive CWPPRA funding through FY22. Over the next three years, CPRA projects between $62 and $68 million in CWPPRA funds annually (CPRA, 2019b).

Analysis

The creation of the CPRA had a large impact on Louisiana's coastal resilience. Not only did it allow the state to receive federal funds, which would eventually result in the construction of the Hurricane & Storm Damage Risk Reduction System (HSDRRS), a series of levees,

floodwalls, gates, and pumps which protect New Orleans, but it also elevated the issue of resilience while consolidating and dedicating resources for it.

Louisiana's coastal protection measures are forward thinking and well established. However, two problems stand out. One is the shortfall between necessary projects and projected revenues. The second is the sustainability of CPRA's funding sources. Beginning in FY21, CPRA's expenditures will outpace revenues (CPRA, 2019b). This trend is projected to continue into FY22. The main driver of this is not revenue stagnation: on the contrary, revenues will increase to over $1 billion in FY22 from $813 million in FY20. Instead, rising construction costs are the primary cause of expenditure increases. In FY20, construction will account for 65 percent, or $486 million, of total CPRA expenditures. This rises to 81 percent, or $768 million, in FY22 (CPRA, 2019b). One reason for this may be that projects which are currently in the planning or design face may soon shift into construction. CPRA's projections show that spending on planning and design is projected to decrease. A larger problem for CPRA and Louisiana may be the fact that a large sum of projected expenditures have not yet been funded. There are eight projects without funding sources in FY20, totaling $162 million. In FY22, this balloons to 16 projects collectively projected to cost $644 million. In the scope of Louisiana's larger, 50-year, $50 billion coastal master plan, which was prepared by CPRA, funding is similarly lacking. CPRA has identified between only $9 and $11 billion in funding sources for the project, or roughly one-fifth of what is needed (EDF, 2018).

What this long-term shortfall points to is a lack of sustainable funding sources. Though funding from *Deepwater Horizon* litigation is significant, it does not have the longevity required to fund long-term resilience. Funding from many *Deepwater Horizon*-linked sources expires in

2031. After this date, CPRA must find additional funding sources to alleviate the loss of over 40 percent of its revenues. CPRA's reliance on GOMESA funding may also present an issue going forward. As climate action becomes more politically pertinent and actionable, fossil fuel revenues may decline naturally or due to regulation. Going forward, this could equate to significantly less funding available through GOMESA. Counting on revenue from budget surpluses and CWPPRA, which has yet to be reauthorized, may also prove to be untenable positions. While CPRA has grappled internally with questions on post-2031 funding sources and the implications of potential economy-wide decarbonization, they have yet to publicly present alternatives to either issue (Interview with Charles Sutcliffe, November 6, 2019).

One area in which the CPRA model excels is in its organizational structure. The CPRA chairman is a cabinet-level position within the Governor's office (Office of the Governor, 2019). This placement has elevated the issue of coastal resilience and more acutely focused efforts to adapt the coastline against climate impacts (Interview with Charles Sutcliffe, November 6, 2019). In addition, the state has a Chief Resilience Officer for Coastal Activities who also serves within the CPRA. CPRA itself has also driven the conversation around coastal resilience in Louisiana. Consolidating coastal resilience measures under one roof has allowed the CPRA to become the authority on the issue and to present a coherent, comprehensive, and singular message on resilience through interactions with the public and the media (Interview with Charles Sutcliffe, November 6, 2019). This was not and could not have been the case prior to CPRA's advent, when resilience initiatives were fractured and spread amongst a number of different state agencies. The consolidation of coastal resilience under CPRA has also had financial benefits. When coastal resilience was diffused across different agencies, those agencies were forced to

compete against each other for funding opportunities. Prior to the CPRA, different state agencies were applying to the same federal grants, reducing the overall amount of funding for coastal resilience in the state (Interview with Charles Sutcliffe, November 6, 2019). The integration of different coastal resilience programs has eliminated this competition, allowing federal funds to be funneled and consolidated, and enabling CPRA to fund higher-cost resilience projects. Lastly, CPRA's science-based approach and multiple funding sources have made the agency itself resilient. It has avoided political partisanship by basing project funding on transparent, science- and model-based estimates. It has also persisted through multiple gubernatorial administrations, including those of both major parties (Interview with Charles Sutcliffe, November 6, 2019). Its reliance on multiple funding sources, rather than just the state budget, has and will allow it to persist in the face of opposition, political or otherwise, and state budget shortfalls.

What Makes Louisiana Different? A Comparison to Other At-Risk States

As has been shown through the previous evaluations, Louisiana is ahead of other states by a number of metrics when it comes to coastal adaptation and resilience. Louisiana has appropriated significantly more resources towards coastal resilience. The CPRA has also been transparent about their funding sources and decision-making processes. Public documents show how the CPRA decides which projects to invest in. The authority also bases funding decisions exclusively on climate science, enabling them to maximize benefits and reducing the potential for politically-motivated appropriations. Though there are issues with CPRA's funding sources as discussed previously, the authority nonetheless has significant recurring revenue streams which enable them to fund a number of high-impact, long-term projects. This differs from most states: only Massachusetts has made investments of a similar magnitude. While it is difficult to

assess state resilience funding sources due to lack of transparency, it appears that Louisiana is the only one with specific revenue streams dedicated to resilience. Louisiana joins three states, Florida, Virginia, and Rhode Island, in having a chief resilience officer. Only Louisiana and Virginia have positions focused specifically on coastal resilience.

Louisiana is a leader on the issue of climate resilience for a number of potential reasons. These have to do with experience and history, demographics, and access to revenue sources. The coastal demographics of the state also differ from many others. Those who have been most impacted by past storm events, including Hurricane Katrina, have predominantly been minorities and low-income populations (Curtis and Schneider, 2011). Many of the communities that still dot the coast come from similar demographics. The Louisiana coast is home to large communities of Asian, Black, and indigenous people, many of whom are both low-income and rely on the coastal waters for their sustenance and economies (Colten et al., 2018). This differs greatly from many other states where the coasts are populated by, if not a majority, a plurality of higher-income populations (Curtis and Schneider, 2011). For this reason, Louisiana coastal communities are ill-equipped, by virtue of having fewer financial resources and coming from historically underserved populations, to adapt to climate change. This may have exacerbated the need for the state to create an apparatus to do just that.

Louisiana also has access to financial resources which other states do not. *Deepwater Horizon* settlement funds and GOMESA revenues, for example, are only available to a select few states. The hundreds of millions of dollars they provide for Louisiana's coastal resilience are not available to other states.

Recommendation

Climate change resilience is too cross-cutting of an issue to have actions related to it be coordinated by an extant agency. This challenge has already been recognized by at least one candidate for President in 2020 (Tom Steyer, 2019). Creating a new agency and position on climate change resilience would elevate the issue and reduce fragmentation of resilience efforts.

Taking from Louisiana's model, the President should seek Congressional approval to create a new agency dedicated to resilience under DHS, due to the Department's mission of public security and disaster mitigation. The new agency should have an office dedicated specifically to coastal resilience. The agency should consolidate existing federal offices, bureaus, and funding sources related to resilience, including FEMA's relevant grant programs.
The administrator of the agency would function as a nationwide chief resilience officer. The President could, if plausible, seek Presidential reorganization authority to create such an agency independent of Congress.

Following the lead of Louisiana, Florida, Virginia, and Rhode Island, the President should create a nationwide position on resilience. This will similarly elevate the importance of adaptation and resilience and allow efforts to be coordinated and mainstreamed. Creating an office dedicated to coastal resilience will have similar effects as the position on resilience, but targeted specifically at the most areas in the country most vulnerable to SLR, hurricane damages, erosion, and other coastal impacts. This office could consolidate many of the disparate funding sources already available for coastal resilience, allowing for high-impact, high-cost projects to be funded. The agency could also benefit from further Congressional appropriations.

The President may wish to adopt Louisiana's "polluter pays" method of funding coastal resilience, and direct the Department of Justice to join existing state lawsuits or launch new cases against corporations deemed liable or negligible in their actions, as it relates to climate change. This could significantly increase the amount of funding available for coastal resilience. The agency should adopt the CPRA's methods of project selection by using the latest climate projections to inform project-specific appropriations. The agency should consider creating grant programs using set-asides, as in FEMA's BRIC program, in order to insulate funds from Congressional action.

Policy Alternative: FEMA's Disaster Deductible

Disaster Deductible Background

In 2016, FEMA published a proposed rule on a disaster deductible concept. It would effectively condition disaster aid on pre-disaster levels of resilience. It would specifically apply to Public Assistance (PA) funds. The PA program provides funding for emergency work, repairs, and related management costs in states and localities in which a presidential disaster declaration has been issued (Brown and Richardson, 2015). The PA program is funded from Disaster Relief Fund DRF appropriations and made up approximately 47 percent of DRF expenditures between FY2000 and FY2013, which equates to $52.6 billion in grants (ibid.). Between FY2005 and FY2013, 65 percent of PA grants were for permanent work, meaning repairs, reconstruction, and replacement (Federal Register, 2017).

The concept of the disaster deductible was driven primarily by budgetary concerns. These concerns can be separated into three categories: 1) the increasing frequency and damages caused by disasters, 2) the drawbacks of FEMA's per capita indicator, and 3) the 2013 budget sequestration.

As has been addressed previously, natural hazards are occurring more frequently and with greater intensity due to the influence of climate change. This has caused a strain on FEMA's disaster relief budget. When the cost of response and recovery exceeds the amount available in the DRF, which happens nearly every year, Congress is forced to issue supplemental appropriations. Since 2004, Congress has approved $89.6 billion in supplemental appropriations for the DRF (Lindsay, 2014). This is neither sustainable nor ideal due to the litany of issues that supplemental appropriations present. Supplemental appropriations can exceed spending limits, therefore enticing lawmakers to underfund the DRF during the appropriations process. They are often rushed through Congress, resulting in funding being based on potentially less accurate cost estimates due to lack of time to assess damages. Lastly, irrelevant riders may be attached to supplemental appropriations, slowing down the process and delaying much needed aid to affected communities (Lindsay, 2014). These budgetary shortfalls had also been noted by both the DHS Inspector General and the Government Accountability Office (Interview with Craig Fugate, November 7, 2019).

FEMA's per capita indicator has also increased agency expenditures. Following a disaster, FEMA makes a recommendation to the President on whether to provide federal assistance or not. A primary factor in this recommendation is the per capita indicator. The indicator, which came into usage in 1986, assesses the financial capacity of a state to respond to

a disaster. The initial per capita threshold was $1, with a minimum of $1 million (§206.48, 1999). The per capita indicator remained $1 from 1986 until 1999, when FEMA began to take inflation into account. However, inflation was not added retroactively. This means that the per capita indicator lags behind what its value should be. Since 1986, per capita personal income, upon which the indicator is based, has risen over 300 percent. The per capita indicator, however, has only risen 31 percent during the same time span. This has resulted in a number of disasters being declared which otherwise would not have been declared. If the per capita indicator had kept pace with income increases, 70 percent of the disasters between 2005 to 2014 would not have been declared, resulting in $5 billion saved by the federal government.

The final driver behind the deductible was the 2013 budget sequestration (Interview with Craig Fugate, November 7, 2019). The government shutdown necessitated budget cuts across most government agencies and functions, FEMA included. In response to these cuts, FEMA was forced to take stock of how and when they provided disaster relief. FEMA staff were asked to look at what the agency was obligated to do, and how it would operate differently with a clean slate (Interview with Craig Fugate, November 7, 2019). These internal discussions led to the creation of the deductible concept.

These three fiscal issues, increasing disaster costs, unnecessary spending, and required budget cuts, pushed FEMA staff to investigate innovative policy proposals which would ease the burden of disaster assistance on the federal government. Their recommendation – the disaster deductible – would decrease federal spending while incentivizing local-level resilience.

Disaster Deductible Explained

The purpose of the deductible is to reduce federal spending on disaster relief and state reliance on the federal government while encouraging states to take proactive measures to guard against disaster-related damages. Under the deductible model, a state would only receive non-emergency PA funding after spending a certain, predetermined amount of money on adaptation, resilience, and response. This predetermined amount, or deductible, is calculated by FEMA and is based off of a state's fiscal capacity and disaster risk. The deductible could be lowered through a series of credits designed to incentivize state spending on resilience-related best practices.

Deductible Methodology

Fiscal capacity was determined through a number of indicators, including per capita Total Taxable Resources, per capita surplus and deficit, per capita reserve funding, and the state's bond rating. To calculate a state's risk level FEMA used Average Annualized Losses (AAL), which is calculated using the likelihood of a hazard occurring in a given year and the likely cost of the hazard if it happens. AAL data was collected from FEMA's Hazus tool, and was then converted into a composite risk index. Fiscal capacity was multiplied by 0.25 and the risk factor was multiplied by 0.75 to produce a state's base deductible.

Deductible Credit

To offset deductible costs and further incentivize states to invest in resilience and other disaster-related best practices, FEMA has proposed a credit system. There are 7 proposed categories of credit.

1. **Dedicated Funding for Emergency Response/Recovery Activities**

FEMA wants states to be fiscally prepared for disaster to strike. Rather than having to divert resources, quickly raise funds, or take other measures which may harm unrelated programs and slow recovery time, states should have a dedicated fund for disaster response and recovery. For every $1 a state appropriates for this use, $1 in credit is earned. This credit can account for up to 20 percent of a state's deductible.

2. **Expenditures for Non-Stafford Act Response and Recovery Activities**

Broadly, the Stafford Act dictates how the federal government responds to disasters. For a state or locality to receive federal disaster aid, there must be a presidential disaster declaration. However, this declaration may not cover communities that, while affected to a lesser extent than those which bore the brunt of the disaster, were still impacted by the disaster in some way. Damages can often exceed local capabilities while still falling short of the criteria for federal aid, necessitating state assistance. Therefore, this credit incentivizes states to continue providing and to increase aid to localities impacted. For every $1 in state spending on response or recovery from an incident not included in a federal disaster declaration, $1 in credit is earned. This credit may account for up to 20 percent of a state's deductible.

3. **Expenditures for Mitigation Activities**

In order to incentivize specific resilient practices, FEMA proposed a credit for pre-disaster mitigation actions. This credit is based on expenditures for non-federally funded projects or projects in which a state exceeds minimum cost sharing thresholds for federal funding. Eligible projects are defined under FEMA's Hazard Mitigation Assistance Guidance, and include property acquisition and demolition/relocation, structural elevation, ignition-resistant construction, and soil stabilization. For every $1 spent on eligible mitigation activities, a state

would receive $3 in credit. Due to the importance of building resilience, FEMA would not cap this credit.

4. **Insurance Coverage for Public Facilities, Assets, and Infrastructure**

Insurance coverage can be a crucial component of a state's ability to bounce back from a disaster. In order to qualify for this credit, a state must have either self-insure or purchase a policy that provides guaranteed coverage for natural hazards, fires, explosions, floods, or terrorist attacks. This credit has no cap, and would reduce the deductible by a percentage specified by the amount of coverage above the deductible amount.

5. **Building Code Effectiveness Grade Schedule (BCEGS)**

Implementing building codes is an effective form of resilience. To incentivize this, FEMA devised a credit that recognizes strong building codes. BCEGS provides a rating system to assess the strength and effectiveness of building codes on a 1 (highest) to 10 (lowest) scale. A state's BCEGS score is calculated by averaging the BCEGS score of every participating community within the state, each of which is evaluated every three to five years (Verisk, 2019). The credit would be applied on a graduated scale corresponding with the state's BCEGS score. For instance, a score of 1 would qualify for a credit equal to 20 percent of the state's deductible. Based on 2015 state BCEGS scores, the average state would qualify for a 16 percent reduction to their deductible.

6. **Tax Incentive Programs**

This credit functions almost as a form of reimbursement for state tax incentives. For this credit, FEMA would allow states to count programs of their choosing, rather than prescribing specific types of incentives. However, the incentive program must be focused on preparedness,

mitigation, or resilience. An example of a qualifying program is offering income tax credits for elevating homes. This credit would not be capped, and a state would receive $2 for every $1 expended on direct costs, such as advertising or administration, and foregone costs, such as lost tax revenue.

7. **Expenditures on State Emergency Management Programs**

This credit seeks to push states to invest more of their own funds into emergency management programs, which the federal government has often funded. Specifications for program eligibility have not yet been promulgated. For every $1 invested by a state in emergency management programs, a $1 credit would be applied to the deductible, for up to 20 percent of the deductible.

Responses to the Deductible

Upon initial publication of the proposed deductible in the Federal Register, the concept was met with mixed reactions. Support for the deductible emanated from a diverse faction of conservative think tanks, environmental groups, advocacy organizations, and even some states, who saw it as a better option than changing the per capita indicator (Interview with Craig Fugate, November 7, 2019). Current FEMA Administrator Pete Gaynor, who was the Director of the Rhode Island Emergency Management Agency at the time, offered support for the concept in a comment to the Federal Register (Gaynor, 2016). The deductible was supported by groups from the insurance industry, including Swiss Re, and the National Association of Mutual Insurance Companies. Groups who are at the forefront of the activities that would be counted for credits, like the Association of State Floodplain Managers, the Insurance Institute for Business and Home Safety, and the National Institute of Building Sciences, supported the concept.

Environmental advocacy organizations, including the Union of Concerned Scientists, the Natural Resources Defense Council, The Nature Conservancy, and the Environmental Law Project. They were joined by the Heritage Foundation and the R Street Institute, both conservative think tanks who applauded FEMA's efforts to reduce costs and the federal role in disaster relief. Though the proposal was made during the Obama administration, James Carafano, who lead President Trump's transition team for DHS, voiced his support for the concept (Flavelle, 2017).

Opposition to the deductible came primarily from those representing PA recipients and subrecipients (county and local government). The main criticisms voiced centered on the legality of the deductible and the impact it would have on state, county, and local abilities to respond to and recover from disasters. A number of governors and state agencies voiced their disapproval of the concept. The National Governors Association voiced opposition to the possibility of adding an additional financial burden to states (NGA, 2016). Similarly, the National Conference of State Legislatures, National League of Cities, and U.S. Conference of Mayors presented concerns about the deductible's inability to account for local level investments in resilience. They also questioned the legality of the proposal, which will be discussed below (NCSL et al., 2016). A number of elected officials also decried the proposal, believing it would put too much of a burden on states while limiting the effectiveness and timeliness of disaster response (Thompson, 2016; Illinois Congressional Delegation, 2017). They also mentioned potential legal barriers. Finally, two organizations representing utilities, the American Public Power Association and the National Rural Electric Cooperative Association, also voiced concerns about the legality of the concept as well as the burden it would place on recipients and subrecipients (NRECA, 2016).

Noted Drawbacks

The Stafford Act requires the federal government to provide at least 75 percent of the cost for essential assistance, repairs, reconstruction, restoration, and replacement following a federally-declared disaster (Stafford Act, 1988). Increasing the amount of funding a state is responsible for would potentially decrease the federal share of funding in certain situations. In practice, this may violate the Stafford Act. This was noted by both proponents of the deductible, like the Heritage Foundation, and opponents. Although legal considerations must be studied further, Congress may have to amend the Stafford Act in order for the disaster deductible to be legal.

One primary drawback of the proposal, regardless of its legality, is its sole focus on state actions. Only state government actions would count towards credits, despite the fact that many localities have been taking action to become more resilient, and are oftentimes better positioned to do so. Some of the activities that would count towards credits, such as instituting building codes, take place primarily at the local level. FEMA has not created a mechanism to take these local level activities into account.

A third concern about the deductible is the methodology used to calculate risk and fiscal capacity. A primary tool used to calculate risk was FEMA's HAZUS program. HAZUS accounts for earthquake, hurricane, flood, and tsunami hazards (FEMA, 2019e). While this covers the hazards which pose the greatest risk to coastal communities, HAZUS does not model for wildfire, tornado, hail, and straight-line wind events (Swiss Re, 2017). The fiscal capacity calculation likewise has potential issues. Since lesser fiscal capacity theoretically lowers the deductible amount, poor handling of state finances could produce a beneficial result for a state.

This may perversely reward unsatisfactory financial decisions (Swiss Re, 2017). Lastly, it does not account for variations in local or county level fiscal capacities. This relates to the concerns voiced by many local actors that the deductible would not properly account for their credit-eligible actions and fiscal needs, as differed from the state as a whole.

Recommendation

The proposed deductible, as is, does not do enough to incentivize resilience. FEMA should consider creating an additional credit that incentivizes states to create CPRA-like authorities. Louisiana has greatly improved their resilience through the advent of the CPRA: creating similar authorities in other states would likely both increase resilience and reduce federal disaster aid costs.

Additionally, FEMA should continue to investigate and refine the disaster deductible. However, they must first examine the legality of the proposed deductible as it relates to the Stafford Act. If it is determined that the deductible runs afoul of the Stafford Act, FEMA should work with Congressional partners to amend the Act, though this may be unlikely due to past concerns from lawmakers. In the case of its legal or illegality, FEMA should nonetheless pursue refinements of the proposal. First, FEMA should investigate how local activities, such as building codes, can be incorporated into the deductible and its credit structure. Second, FEMA should consider replacing or supplementing HAZUS and their fiscal capacity method to create a more holistic risk assessment and a more incentivizing structure for state spending on resilience, respectively.

Policy Alternative: NFIP Reform and CBRA Expansion

NFIP History and Basics

The National Flood Insurance Program (NFIP) is a federal program administered by FEMA that provides flood insurance to homeowners. The NFIP was established by Congress in 1968 in response to the lack of private insurers willing to insure homes in the floodplain and the increasing burden that disasters imposed on the federal government (Horn and Webel, 2019; Huber, 2012). The NFIP is a voluntary program that is available to communities, defined as states or any subdivision of a state, except those covered by the Coastal Barrier Resources Act (CBRA) (Huber, 2012). In return for NFIP coverage, communities agree to adopt minimum floodplain management standards, which includes limiting development in the Flood Hazard Areas (SFHAs) (Horn and Webel, 2019). Communities enrolled in the NFIP may decrease their premiums further by joining the Community Rating System (CRS). The CRS program ranks communities into classes ranked 10 (lowest) to 1 (highest) based on resilience, outreach, and management activities which exceed NFIP-mandated minimums (FEMA, 2017). Each class improvement results in a 5 percent discount on flood insurance premiums for policyholders within a community (ibid.).

The NFIP is attractive to communities for a number of reasons. First, private insurers often deny coverage or only offer plans with extremely high premiums to communities with high flood risk or a history of recurring flood events. In contrast, NFIP has no mandate to create a profit, and can therefore keep premiums low (Huber, 2012). This allows homeowners to obtain insurance at reasonable rates. Enrolling in the NFIP also mandates that a community adhere to

minimum floodplain standards, which builds resilience. This benefits the federal government as well, because disaster recovery expenditures will theoretically decrease in response to increased resilience.

The NFIP receives revenue from three sources: flood insurance premiums, Congressional appropriations, and the U.S. Treasury. As of November 2018, premiums accounted for $3.6 billion in revenue; Congressional appropriations accounted for nearly $2 billion in FY19; and is loaned money by the Treasury on a case-by-case basis (Horn and Webel, 2019).[5] Since 2018, the NFIP has attempted to increasingly transfer risk to the private sector while raising revenues through the issuing of catastrophe bonds. Through FEMA, the program's first catastrophe bond was issued in August 2018 and transferred $500 million worth of risk. Since then, the agency has issued one more catastrophe bond, worth $300 million (Insurance Information Institute, 2019). Currently, the NFIP insures roughly 5.1 million homeowners and $1.3 trillion worth of assets (FEMA, 2019i).

The CBRA Exception

The only areas specifically disallowed from receiving NFIP coverage are those which fall under the CBRA. Areas covered by a CBRA designation are those which serve as natural barriers against coastal storms and hurricanes (FWS, 2019c). The CBRA prohibits federal expenditures of nearly every kind in the area with few exceptions (ibid.) The motivation for the CBRA was to remove incentives to develop in high-risk areas while minimizing federal disaster relief expenditures (Lipiec and Crafton, 2019). Congress must authorize the addition of new areas to the CBRA (FWS, 2019c). Though the CBRA is not able to disallow local government

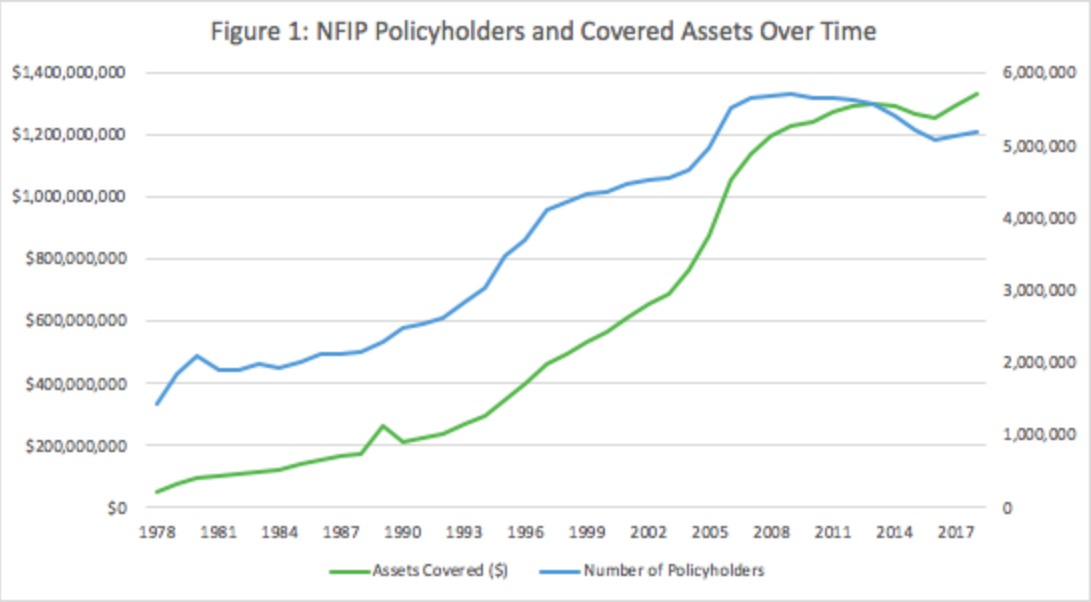
[5] Congress has increased NFIP funding over time.

expenditures, private development, or private insurers from operating within a given area's boundaries, it has nonetheless produced significant benefits due to a reduction of moral hazard. A 2002 study by the FWS, which oversees the act, found that the CBRA had produced $686 million in savings between 1983 and 1996 due primarily to avoided disaster relief and infrastructure costs (Lipiec and Crafton, 2019). A 2019 study found the CBRA's benefits to be even greater: the CBRA reduced federal disaster expenditures by $9.5 billion between 1989 and 2013. The study projects that the CBRA will additionally save between $11 billion and $108 billion by 2068 (Coburn and Whitehead, 2019). The large discrepancy in estimates is explained by the use of different scenarios based on varying development and damage rates (ibid.).

Current Issues with the NFIP

While the number of policyholders has declined in recent years, the value of assets covered has increased (FEMA, 2019h). This suggests that wealthier policyholders, or at least policyholders with more valuable homes, are increasingly taking advantage of the NFIP's low-cost premiums, an assertion which is backed up by a number of studies (Figure 2). Wealthier households tend to pay lesser premiums and 80 percent of NFIP-insured homes are located in counties that are in the top quintile of income (Brannon and Blask, 2017; Ben-Shahar and Logue, 2016). 40 percent of NFIP-insured coastal properties are worth more than $500,000, 12 percent are worth more than $1 million, and 23 percent are not the policyholder's primary residence (CBO, 2007). A major tenet of the program is to subsidize insurance for those who would otherwise be unable to afford it (Horn and Webel, 2019). Instead, the program is, to an extent, providing a lower-cost option to those who could presumably afford private insurance. This unnecessarily puts a greater strain on federal resources in the event of a flood. Furthermore, a

small percentage of NFIP-insured properties are responsible for a significant amount of claims. Repeatedly flooded properties make up 1 percent of covered properties but account for 25 to 30 percent of all claims (Pew Charitable Trusts, 2016). These properties alone have cost the NFIP $12.5 billion (ibid.).



Source: FEMA Statistics by Calendar Year, 2019.

Another problem faced by the NFIP is its cost. Per its Congressional authorization, the NFIP is allowed to borrow no more than $30.425 billion from the Treasury over its lifetime (Horn and Webel, 2019). Following Hurricanes Harvey, Irma, and Maria in 2017, the NFIP reached its borrowing limit. In response, Congress cancelled $16 billion of the NFIP's debt, the first time they had ever done so. Two weeks after the debt cancellation, the NFIP was forced to borrow another $6.1 billion, (ibid.). As of the third quarter of 2019, the NFIP has $9.9 billion in borrowing power remaining and $20.525 billion in outstanding debt (FEMA, 2019h). The NFIP loses roughly $1.4 billion each year (Dinan, 2017). As climate change induces greater disaster costs, NFIP claims will likely increase. This may force the NFIP to continue borrowing up to

their limit, putting Congress in a situation where they may have to cancel NFIP debt once again. This is neither a desirable nor sustainable strategy, and one which will only increase costs over time.

Some believe that the minimum floodplain management standards mandated by entry into the program are not effective enough. While communities may adopt higher standards for premium reduction through the CRS, this is by no means a requirement. As of 2017, only 5 percent of NFIP-participating communities had qualified for the CRS (FEMA, 2017b). The Association of State Floodplain Managers (ASFPM) has stated that "the minimum NFIP floodplain regulations do not provide adequate long-term flood risk reduction for communities," (ASFPM, 2013). Given that risks will only increase with the progression of climate change, these inadequate standards will not effectively create resilient communities and will increase NFIP debt as claims rise.

A final issue with the NFIP is that it perversely incentivizes development in high-risk areas due to incorrect pricing of risk. This moral hazard is due to the fact that NFIP premiums are not priced commensurately with risk, as evidenced by the NFIP's large outstanding debt (Cato Institute, 2017). If the premiums were priced correctly, they would adequately cover NFIP claims. This is due to a number of reasons. One is that the flood maps FEMA uses to assess risk and calculate premiums are often outdated. A study by the DHS Investigator General revealed that 58 percent of these maps are outdated and considered inaccurate (Scata, 2017). For example, a property formerly considered outside of the highest-risk zones paid a premium of $429 a year. If updated maps with greater accuracy were to show that this property was now in a high-risk zone, the premium for the same amount of coverage would range between $5,000 to $10,000 per

year (Ben-Shahar and Logue, 2016). As climate change increases the reach of coastal flooding, this problem will only be exacerbated. A second issue is that the government does not currently take development, long-term erosion trends, or climate change into account when developing premium rates (Ben-Shahar and Logue, 2016). This has inadvertently incentivized development in high-risk flooding areas (Silvis, 2017; Ben-Shahar and Logue, 2016). This inherently puts more people, property, and assets at risk of coastal climate impacts.

Potential Reforms

The Trump administration has proposed a number of reforms to the NFIP. These suite of reforms are collectively known as Risk Rating 2.0, and are anticipated to come into effect by 2021. The new system was originally planned to be implemented in 2020. However, outcry from politicians, including a bipartisan group of 64 Congressmembers, concerned that policyholders would face significant increases in premiums, forced the new system to be delayed for further study (Warmbrodt, 2019). Risk Rating 2.0 will incorporate a larger range of potential flood events when calculating premiums and delineating at-risk areas: up to this point, the NFIP has only taken 100-year flooding events into account (FEMA, 2019c). The new rating will factor in the cost to rebuild an individual home, which officials have said will help the inequity of wealthier policyholders paying equal or lesser premiums than less wealthy policyholders. It will also take distance from the coast into account (Warmbrodt, 2019b).

Others have called for a strengthening of minimum floodplain standards. As discussed previously, the ASFPM outlined a number of standards that the NFIP could adopt. The Center for Climate and Energy Solutions proposed similar reforms of both the NFIP and CRS. They suggested adopting standards based on 500-year flood events and tying CRS incentives to

actions that are more correlated with risk reduction (Huber, 2012). In 2015, President Obama signed E.O. 13690, which mandated that federally-funded projects be built either two feet above the base flood elevation for 100-year flooding events or to the 500-year flood elevation (E.O. 13690, 2015). As evidenced, both the government and nongovernmental organizations have identified building to 500-year flood standards as a best practice.

Recommendation

The NFIP could be a powerful tool to increase resilience, but, in its current form, it fails to do so. In order to rectify this, FEMA should institute stronger mandatory minimum standards based on 500-year flood levels for the NFIP in order to increase the resilience of communities at risk of flood damage. Standards should be phased in over a number of years as determined by FEMA, the Water Resources Council, and the Federal Interagency Floodplain Management Task Force, the latter two of which were responsible for implementation of E.O. 13690. NFIP policyholders who have not adopted the 500-year standards in the allotted time should be removed from the NFIP. In addition to increasing resilience, this proposal would also likely reduce NFIP expenditures by lessening the amount of claims due to the higher standards. This proposal could also potentially reduce premiums over time, as those who have adapted to or above 500-year standards will have their flood risk greatly reduced.

In order to further incentivize adaptation and resilience in communities while keeping the NFIP solvent, premiums must accurately reflect risk. Therefore, FEMA should follow through with the implementation of Risk Rating 2.0, despite objections from lawmakers.

Separately, FWS should conduct research relating to the expansion of CBRA. Specifically, FWS should seek to identify areas which will be at high risk of future coastal climate impacts and if

CBRA could be expanded to encompass or protect such areas. Expanding CBRA areas would create stretches of natural green infrastructure that would protect inland areas from climate change-induced damages.

Policy Alternative: Resilience Tax Credits

Tax Credits

A potential policy prescription for increasing the resilience of coastal property is by providing incentives through tax credits. Such credits would not only encourage business- and homeowners to retrofit their buildings, but it would also help lower-income owners to make needed upgrades that may have been cost-prohibitive. There have been a number of proponents of this approach, including the Office of Management and Budget under the Obama administration and the Insurance Institute for Business and Home Safety (OMB, 2016; The Economic and Health Consequences of Climate Change, 2019).

A resilience tax credit could be modeled after the Residential Energy Efficient Property Credit (ibid.). This nonrefundable credit counts for 30 percent of the cost for alternative energy equipment and its installation (IRS, 2017). Though the effectiveness of this specific credit is difficult to discern due to uncertainty about whether individuals would have made energy efficiency purchases in its absence, a regression analysis of an earlier, similar credit found that a 10 percentage point increase in the federal credit was associated with a 24 percent increase in the probability of a household making an investment in energy efficiency (Crandall-Hollick and Sherlock, 2016; Hassett and Metcalf, 1995). It is plausible that a similarly structured resilience tax credit would also increase the number of households investing in retrofits.

One legislative option related to this has already been introduced. The Disaster Savings and Resilient Construction Act of 2018, versions of which have been introduced in multiple previous sessions, would establish a federal tax credit for resilience (H.R. 6841, 2018). The amount of credit provided by this proposed legislation would be 1 percent of the cost of the property, or $25,000 for businesses and $3,000 for residential property. However, the credit would be available only to rebuilding properties encompassed in a federally declared disaster. Resilience would be defined as meeting International Building Code standards from 2009 or later, or receiving IBHS FORTIFIED accreditation (ibid.). Neither of these standards deal with flood risk, likely due to the fact that building standards related to flood risk are governed by the NFIP.

Recommendation

Tax credits for resilience may provide a strong incentive for homeowners to retrofit their properties and adapt to climate change. Past studies have shown that similar credits are effective at influencing consumer behavior. While the goals of the Disaster Savings and Resilient Construction Act of 2018 are commendable, it falls short of sufficiently building coastal resilience. In order to adequately prepare the coast and produce the most benefits, adaptation and resilience should be proactive rather than reactive. While post-disaster resilience may be an easier task, it is less effective, as losses will have already occurred. By restricting tax credits to areas within a federally-declared disaster zone, the Disaster Savings and Resilient Construction Act neglects areas that will become more vulnerable in the future due to climate change. Its use of IBHS FORTIFIED and International Building Code standards is also too restrictive to increase coastal resilience under current conditions.

An opportunity exists to use tax credits to help business- and homeowners, specifically low-income ones, conform to the new NFIP standards proposed in this thesis. This would alleviate financial strain and mitigate potential inequitable outcomes. Congress should create a tax credit, modeled on the Disaster Savings and Resilient Construction Act, which will specifically help low-income NFIP policyholders comply with the proposed 500-year floodplain standards by providing credits for applicable retrofits. Such a tax credit would increase the resilience of communities at risk of severe flooding, and would provide necessary assistance to low-income business- and homeowners.

Assessment

In the following section, I will assess the proposal which creates a new agency dedicated to resilience, Office of Coastal Resilience, and administrator for resilience. This proposal was selected for assessment over others for the following reasons: the disaster deductible and NFIP reform have already faced considerable pushback from Congress; there is limited information available for making the well-rounded and quantitatively-backed assessment necessary for tax credits and CBRA expansion; and the assessed proposal is both unique and large-scale.
I will assess the proposal according to a series of criteria: 1) Will the proposal quickly and effectively increase coastal resilience? 2) Will the proposal plausibly gain Congressional approval? 3) Will the proposal have long-term staying power? 4) Will the proposal have unintended negative or inequitable outcomes?

Will the proposal quickly and effectively increase coastal resilience?

It is difficult to project outcomes for a less quantitatively-grounded policy proposal. Therefore, in order to assess its effectiveness, one must look to Louisiana and the CPRA. There are a number of ways in which its impact on coastal resilience must be examined: funding, project appropriation, and general elevation of the issue.

Funding

As was previously noted, cost estimates for sufficient coastal adaptation are highly variable but incredibly costly nonetheless. Current federal appropriations for coastal adaptation and resilience spans somewhere between $4 and $10 billion per year (albeit with a number of conditions), yet needs are much greater, as discussed previously. It is difficult to say whether available funding would increase were this proposal to be implemented. This would be contingent on a number of factors. For one, it would depend on agency resistance to move current, disparate grant programs and offices related to coastal resilience under one umbrella in the new agency. Second, it would depend on how much Congress appropriates.

History has shown that Congress often appropriates smaller, yet still significant sums to new agencies, and increases appropriations over time. This was the case with the two most environmentally-oriented agencies, the EPA and the Department of Energy (DOE). When the EPA was created in 1970, it was appropriated $1.4 billion, a number which has increased over time (EPA, 1990). The DOE, which consolidated a number of existing offices, had a budget of $10.4 billion in 1977, its inaugural year (DOE, 1994). This has since risen to over $30 billion (Horn and Webel, 2019). The newest federal department, the Department of Homeland Security, received $36.2 billion in FY 2004, its first full year of operation, and has since increased to over $40 billion (DHS, 2019). It should be noted that each of these departments were created in the

wake of specific events: the EPA following a number of large-scale pollution incidents, the DOE following the 1973 oil shortage, and DHS after the 9/11 terror attacks (Spezio, 2018; DOE, 1994).

Another potential funding source may be settlements from litigation against major contributors to GHG emissions. A number of cities and states have already filed suit against fossil fuel companies, alleging fraud, violations of state law, and negligence (Hasemyer, 2019). Should the President instruct the Department of Justice to join existing suits or file new ones, significant portions of settlements and/or penalties from the ensuing litigation could be directed to the new Office of Coastal Resilience, following the model of the CPRA. Though this may not be a sustainable funding source in the long-term, it would likely provide a large sum in the short-term. However, there is no way to predict the settlement amount, given the lack of precedent. Even more importantly, there is no certainty that such a case would turn out favorably for the government – in fact, given the lack of success of state and city efforts thus far, it may very well be unlikely.

Though it is impossible to accurately project Congressional appropriations for a proposed agency, let alone potential legal settlement amounts, history shows that Congress is prone to appropriate several billion dollars to new departments, while steadily increasing appropriations in the years that follow. Though this is promising, it remains to be seen whether this will provide sufficient funding for coastal adaptation and resilience efforts.

Project Appropriation

Similar to the case with coastal protection funding in Louisiana, the consolidation of resources would likely allow higher-cost projects to be funded. This could allow for more high-cost initiatives to be implemented. However, this may in turn neglect smaller projects. Having a larger pool of money with less grant recipients may also put smaller communities at a disadvantage. Many small communities may not have the resources or expertise to effectively apply for large, complex federal grants. Consolidating resources may further perpetuate this issue.

If the new agency uses cutting-edge climate science and projections to choose grant recipients, as the CPRA does, this could make it much more effective. As has been noted previously, FEMA's current grant programs are plagued by a lack of transparency, and do not necessarily take future climate risk into account. Changing this could promote high-impact projects that provide the most benefits going forward, and would eliminate politically-motivated project funding.

Elevation of the Issue of Coastal Resilience

Having an administrator dedicated to resilience would certainly elevate the issue of adaptation and resilience generally. As has been the case in Louisiana, having an agency and position dedicated to coastal resilience would increase the profile of the issue and provide the federal government with a point person on actions related to climate resilience. However, it is difficult to say whether this would affect any changes in public opinion.

Will the proposal plausibly gain Congressional approval?

The answer to this question is dependent on a number of factors. These include the makeup of Congress and the context of the proposal. As was mentioned, the EPA, DOE, and DHS were all formed in response to specific events. This likely increased public pressure on lawmakers to take action. This is backed up by the bipartisan support enjoyed by the acts which established both DOE and DHS. The Homeland Security Act of 2002 passed the House by a 295-152 vote and the Senate by a tally of 90-9 (H.R. 5005, 2002). The act which established DOE in 1977 passed with votes of 310-20 in the House and 74-10 in the Senate (S.826, 1977). The formation of the EPA did not require a Congressional vote because President Nixon had Presidential reorganization authority. Prior to changes in the law, Presidential reorganization could occur without the explicit approval of Congress, though they were able to veto plans (Hogue, 2012). President Obama attempted to gain Presidential reorganization authority from Congress in 2012, but was blocked by Republicans despite initial bipartisan support (Kosar, 2017). The President would likely have to cultivate a positive relationship with Congressional leaders from both parties in order to ensure the establishment of the new agency. This may be easier to accomplish in the wake of a significant natural disaster, based on the precedent of past agency establishment.

Will the proposal have unintended negative or inequitable outcomes?

Consolidating coastal resilience efforts under one agency may silo government-wide initiatives to increase resilience. It may, in effect, reduce the resilience-related functions of other agencies (Goodell, 2019). However, this may be mitigated to an extent by housing the agency under DHS and by staffing deputy administrators from other relevant agencies, which would presumably aid cross-agency collaboration. This proposal may also increase the disparities

between smaller, less well-endowed communities, and larger ones with more resources. Resource consolidation may increase awards but decrease the number of awardees, as higher-cost projects are funded. This will increase competition for grants, giving well-planned proposals an advantage. Communities that do not have the resources needed to conduct detailed studies, produce localized climate projections, and engage experts will therefore be disadvantaged. Given current wealth disparities in America, this could disproportionately harm minority communities.

Conclusion: Final Recommendations

Climate change will greatly impact the U.S. coastline in the near-, medium-, and long-term future. Localities urgently need to adapt and build resilience to these projected impacts. Yet many have not, due prominently to a lack of necessary resources. States, the testing grounds of new and innovative policies, have, for the most part, similarly failed to step up to the challenge. The federal government has begun to work towards building coastal resilience, but has not yet done enough and in some cases even administers policies that are detrimental to the goal. There must be a new and improved approach to building coastal resilience. In light of the analysis presented in this thesis, the following recommendations are made:

The President should seek Congressional approval to create a new agency dedicated to resilience, to be housed under DHS. The agency should include an Office of Coastal Resilience and should consolidate existing relevant offices and funding sources. The agency should utilize climate science to inform funding decisions. The agency should also appoint

deputy administrators who concurrently hold other positions in federal departments. An agency and corresponding administrator for resilience could provide a number of benefits, both in terms of opinion and perception of the issue, and in physically increasing coastal resilience through targeted, high-impact projects. Housing the agency under DHS would be a natural fit, due to the Department's commitment to national security and public safety. To mitigate the potential siloing of federal resilience efforts, deputy administrators should concurrently hold other positions in relevant agencies, departments, or offices. These could include the Department of Commerce, the U.S. Army Corps of Engineers, FEMA, and the Department of Transportation.

FEMA should phase in 500-year floodplain standards for the NFIP over a set period of time, and remove non-compliant policyholders from the NFIP. Congress should act quickly to approve resilience tax credits for low-income NFIP policyholders to help them comply with the new mandatory minimum standards. FEMA should also follow through on the implementation of the NFIP's Risk Rating 2.0 to increase resilience and equity. The NFIP incentivizes development in high-risk areas by not pricing premiums commensurately with past risk, let alone current or future risk. This issue is exacerbated by the relatively weak minimum standards enforced by the NFIP and CRS. Increasing premiums, as Risk Rating 2.0 will do, will show homeowners the true risk of living in a given area, which will theoretically influence behavioral changes. The new methodology will also help reduce current inequities between low- and high-income homeowners. Increasing minimum standards will increase resilience to coastal flooding impacts. It will also likely reduce NFIP expenditures, as less policyholders will suffer damages. Approving tax credits aimed at low-income policyholders will

ensure that they are able to comply with the new standards. However, there is likely to be much Congressional outcry based on precedent. This may force reforms to be abridged or weakened.

Even in the absence of NFIP reforms, **Congress should still approve tax credits for resilience, modeled on the Disaster Savings and Resilient Construction Act of 2018 and on energy efficiency tax credits.** Similar tax credits have been shown to influence consumer behavior. Implementing a tax credit for resilient retrofits could help low-income homeowners and incentivize higher-income homeowners to prepare their properties for climate impacts. However, **Congress must ensure that tax credits are available *proactively*, and not only to communities in a federally declared disaster area**. Building resilience before a disaster strikes will maximize benefits and minimize the loss of life and property. Congress should also consider an expanded definition of resilient retrofits that takes coastal inundation and storm surge into account.

FWS should identify areas which may be amenable to CBRA expansion. The CBRA has generated a significant amount of financial benefits for the federal government since its inception. As rising sea levels and changing hurricane patterns expand the scope of vulnerable coastal areas, FWS should study where those areas may be and if the CBRA could be applied to new domains. This will not only protect lives and property by protecting naturally-occurring "green infrastructure", but will limit federal disaster-related spending as well. FWS should then work in concert with Congress to expand CBRA areas.

FEMA should add a credit to proposed Disaster Deductible that would incentivize states to create CPRA-like authorities, and should continue to refine the Disaster Deductible in cooperation with Congress and state partners. In its current form, the disaster

deductible does not do enough build coastal resilience through incentivization. Adding an additional credit that could be applied to a state's deductible if they create an authority similar to the CPRA would incentivize states to make the large-scale adaptation efforts needed to prepare for climate change. However, a number of outstanding problems remain. FEMA must first determine if the deductible would necessitate the amending of the Stafford Act. FEMA should also strive to incorporate local actions into the deductible and credit structure. Finally, FEMA should reconsider, replace, or supplement the proposed calculations for state risk and fiscal capacity to more holistically represent risk and to ensure the fiscal capacity measure does not inadvertently incentivize poor management. This should be done in concert with state partners and Congress to ensure a broad base of support and the incorporation of concerns.

These recommendations are by no means an assured or complete solution. Climate projections, as with all scientific projections, are variable, and impacts may be worse or occur sooner than currently thought. Nevertheless, the federal government must step up where states and localities are failing. In order to ensure the protection of people, property, and entire economies in the face of climate change, the federal government must take action. The above recommendations can be completed through agency regulation, presidential action, and Congressional legislation. These broad suite of solutions, which are both short- and long-term, can help coastal communities prepare for the impacts of climate change.

Works Cited

§206.48. , Electronic Code of Federal Regulations § Part 206—Federal Disaster Assistance (1999).

2019 National Coastal Wetland Conservation Grants Project Summaries. (2019). Retrieved from https://www.fws.gov/coastal/CoastalGrants/pdfs/2019-Coastal-Wetlands-Grants-Project-Summaries-Final.pdf

About BUILD Grants. (2019). Retrieved December 18, 2019, from DOT website: https://www.transportation.gov/BUILDgrants/about

About The Build America Bureau [Text]. (2019). Retrieved December 18, 2019, from US Department of Transportation (DOT) website: https://www.transportation.gov/buildamerica/about

Act 8. , Pub. L. No. S.B. 71 (2005).

Adaptation Advisory Committee. (2011). *Massachusetts Climate Change Adaptation Report* (p. 128).

Adaptation Clearinghouse. (2019). Retrieved December 18, 2019, from https://www.adaptationclearinghouse.org/

Adger, N. (2000). Social and ecological resilience: Are they related? *Progress in Human Geography*, *24*(3), 347–364.

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., … Wreford, A. (2009). Are there social limits to adaptation to climate change? *Climatic Change*, *93*(3), 335–354. https://doi.org/10.1007/s10584-008-9520-z

Aldunce, P., Beilin, R., Howden, M., & Handmer, J. (2015). Resilience for disaster risk management in a changing climate: Practitioners' frames and practices. *Global Environmental Change*, *30*, 1–11. https://doi.org/10.1016/j.gloenvcha.2014.10.010

Alexander, D. (2013). Resilience and disaster risk reduction: An etymological journey. *Natural Hazards and Earth System Sciences*, *13*. https://doi.org/10.5194/nhess-13-2707-2013

Am, P., Cuccillato, E., Nkem, J., & Chevillard, J. (2013). *Mainstreaming climate change resilience into development planning in Cambodia*. Retrieved from Cambodia Climate Change Alliance website: https://cdkn.org/wp-content/uploads/2013/06/Cambodia_PRESS.pdf

Armey, R. *H.R. 5005 Homeland Security Act of 2002*. , (2002).

Association of State Floodplain Managers (ASFPM. (2013). *A Guide for Higher Standards in Floodplain Management*. Retrieved from https://www.floods.org/ace-files/documentlibrary/committees/3-13_Higher_Standards_in_Floodplain_Management2.pdf

Ayers, J., Huq, S., Wright, H., Faisal, A. M., & Hussain, S. T. (2014). Mainstreaming climate change adaptation into development in Bangladesh. *Climate and Development*, *6*(4), 293–305. https://doi.org/10.1080/17565529.2014.977761

Ayers, J., Kaur, N., & Anderson, S. (2011). Negotiating Climate Resilience in Nepal. *IDS Bulletin*, *42*(3), 70–79. https://doi.org/10.1111/j.1759-5436.2011.00224.x

Ayers, J. M., & Huq, S. (2009). Supporting Adaptation to Climate Change: What Role for Official Development Assistance? *Development Policy Review*, *27*(6), 675–692. https://doi.org/10.1111/j.1467-7679.2009.00465.x

Aylett, A. (2014). *Progress and challenges in the urban governance of climate change: Results of a global survey*. Retrieved from ICLEI-Local Governments for Sustainability & Massachussets Institute of Technology website: https://www.preventionweb.net/publications/view/38666

Bahadur, A., Ibrahim, M., & Tanner, T. (2013). Characterising resilience: Unpacking the concept for tackling climate change and development. *Climate and Development*, *5*. https://doi.org/10.1080/17565529.2012.762334

Bahadur, A., Lovell, E., Wilkinson, E., & Tanner, T. (2015). *Resilience in the SDGs: Developing an indicator for Target 1.5 that is fit for purpose*. Retrieved from Overseas Development Institute website: https://www.odi.org/publications/9775-resilience-sdgs-2030-developing-poor-vulnerable-climate-indicator-target-disasters

Bahadur, A., & Tanner, T. (2014). Transformational resilience thinking: Putting people, power and politics at the heart of urban climate resilience. *Environment and Urbanization*, *26*(1), 200–214. https://doi.org/10.1177/0956247814522154

Bailey, J. (2007). *Lessons from the Pioneers: Tackling Global Warming at the Local Level* (p. 17). Institute for Local Self-Reliance.

Baker, J. L. (2012). *Climate Change, Disaster Risk, and the Urban Poor: Cities Building Resilience for a Changing World*. Retrieved from https://ideas.repec.org/b/wbk/wbpubs/6018.html

Bardach, E., & Patashnik, E. (2012). *A Practical guide for policy analysis: the eightfold path to more effective problem solving* (5th ed.). Los Angeles: Sage.

Ben-Shahar, O., & Logue, K. D. (2016). *The Perverse Effects of Subsidized Weather Insurance*. 57.

Beta.SAM.gov. (2019). Retrieved December 18, 2019, from U.S. System for Award Management website: https://beta.sam.gov/fal/3839fafb6c184f7f9178d24e25c643eb/view

Bierbaum, R., Smith, J. B., Lee, A., Blair, M., Carter, L., Chapin, F. S., … Verduzco, L. (2013). A comprehensive review of climate adaptation in the United States: More than before, but less than needed. *Mitigation and Adaptation Strategies for Global Change*, *18*(3), 361–406. https://doi.org/10.1007/s11027-012-9423-1

Bouwer, L. M., & Aerts, J. C. J. H. (2006). Financing climate change adaptation. *Disasters*, *30*(1), 49–63. https://doi.org/10.1111/j.1467-9523.2006.00306.x

Brannon, I., & Blask, A. (2017a). *Reforming the National Flood Insurance Program: Toward Private Flood Insurance* (No. 817; p. 24). Cato Institute.

Brannon, I., & Blask, A. (2017b, August 8). The government's hidden housing subsidy for the rich. Retrieved December 18, 2019, from Politico website: https://www.politico.com/agenda/story/2017/08/08/hidden-subsidy-rich-flood-insurance-000495

Brennan, W., Schultz, P., Lawson, L., Savonis, M., Burkett, V., Slimak, M., … McNutt, C. (2008). *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I*. Retrieved from U.S. Climate Change Science Program website: http://www.iooc.us/wp-content/uploads/2010/09/Impacts-of-Climate-Change-and-Variability-on-Transportation-Systems-and-Infrastructure-Gulf-Coast-Study-Phase-I1.pdf

Brown, J. T., & Richardson, D. J. (2015). *FEMA's Public Assistance Grant Program: Background and Considerations for Congress* (p. 64). Congressional Research Service (CRS).

Brugmann, J. (2012). Financing the resilient city. *Environment and Urbanization*. Retrieved from https://journals.sagepub.com/doi/full/10.1177/0956247812437130

Brunner, R., & Nordgren, J. (2012). *Climate Adaptation as an Evolutionary Process: A White Paper* (p. 12). Kresge Foundation.

Bulkeley, H., & Tuts, R. (2013). Understanding urban vulnerability, adaptation and resilience in the context of climate change. *Local Environment*, *18*(6), 646–662.

Bureau of Ocean Energy Management. (2019). Gulf of Mexico Energy Security Act (GOMESA). Retrieved December 18, 2019, from https://www.boem.gov/oil-gas-energy/energy-economics/gulf-mexico-energy-security-act-gomesa

Burton, I. (2009). CLIMATE CHANGE AND THE ADAPTION DEFICIT. *CLIMATE CHANGE*, 9.

Cabinet Committee on Climate and Resiliency (CCoCAR). (2014). *The Climate Framework for Delaware*. Retrieved from http://www.dnrec.delaware.gov/energy/Documents/The%20Climate%20Framework%20for%20Delaware.pdf

Campanella, T. J. (2006). Urban Resilience and the Recovery of New Orleans. *Journal of the American Planning Association*, *72*(2), 141–146. https://doi.org/10.1080/01944360608976734

Carmin, J., Nadkarni, N., & Rhie, C. (2012). *Progress and challenges in urban climate adaptation planning: Results of a global survey*. Retrieved from ICLEI-Local Governments for Sustainability & Massachussets Institute of Technology website: https://www.preventionweb.net/publications/view/27035

CDBG-Disaster Recovery Grant History 1992—2019. (2019, June 20). Retrieved from https://files.hudexchange.info/resources/documents/CDBG-DR-Grant-History-Report.pdf

Cheong, S.-M. (2011). Policy solutions in the U.S. *Climatic Change*, *106*(1), 57–70. https://doi.org/10.1007/s10584-010-9996-1

Climate Change: Governors Talk Resilience, Protesters Demand Action. (2017, July 17). Retrieved December 18, 2019, from EcoRI website: https://www.ecori.org/climate-change/2017/7/17/ieg809naq5dt0k6g6otu50rpcukyz1

CLIMATE READY NORTH CAROLINA Building a Resilient Future. (2012). Retrieved from http://www.climatechange.nc.gov/Climate_Ready_North_Carolina_Building_a_Resilient_Future.pdf

Coastal Barrier Resources Act. (n.d.). Retrieved December 18, 2019, from U.S. Fish and Wildlife Service website: https://www.fws.gov/cbra/Act.html

Coastal Economics and Demographics. (2015). Retrieved December 18, 2019, from NOAA Office for Coastal Management website: https://coast.noaa.gov/states/fast-facts/economics-and-demographics.html

Coastal Protection and Restoration Authority (CPRA). (2017). *Louisiana's Comprehensive Master Plan for a Sustainable Coast*. Retrieved from https://www.fws.gov/doiddata/dwh-ar-documents/1187/DWH-AR0003479.pdf

Coastal Protection and Restoration Authority (CPRA). (2019, March 22). *CPRA FY2020 Annual-Plan*. Retrieved from http://coastal.la.gov/wp-content/uploads/2019/01/CPRA-FY2020-Annual-Plan-3.22.19-Web.pdf

Coburn, A. S., & Whitehead, J. C. (2019). An Analysis of Federal Expenditures Related to the Coastal Barrier Resources Act (CBRA) of 1982. *Journal of Coastal Research*, *35*(6), 1358–1361. https://doi.org/10.2112/JCOASTRES-D-18-00114.1

Coda, C. (2016, March 21). *Comment Submitted by Carolyn Coda, Swiss Re*.

Colten, C. E., Simms, J. R. Z., Grismore, A. A., & Hemmerling, S. A. (2018). Social Justice and Mobility in Coastal Louisiana, USA. *Regional Environmental Change*, *18*(2), 371–383. https://doi.org/10.1007/s10113-017-1115-7

Comment Submitted by Congress of the Unites States (IL Delegation). (2017, April 12).

Community Development Block Grant Disaster Recovery: CDBG-DR Overview. (2019, August 27). Retrieved from

https://files.hudexchange.info/resources/documents/CDBG-Disaster-Recovery-Overview.pdf

Congressional Budget Office (CBO). (2007). *Value of Properties in the National Flood Insurance Program* (p. 20).

Congressional Research Service (2019). (2019). *FY2019 Appropriations for the Department of Energy* (p. 4).

Continuing Authorities Program. (n.d.). Retrieved December 18, 2019, from U.S. Army Corps of Engineers website: https://www.nae.usace.army.mil/Missions/Public-Services/Continuing-Authorities-Program/

CPRA Board. (2019). Retrieved December 18, 2019, from Coastal Protection And Restoration Authority (CPRA) website: http://coastal.la.gov/about/structure/cpra-board/

Crandall-Hollick, M. L., & Sherlock, M. F. (2016). *Residential Energy Tax Credits: Overview and Analysis* (p. 29). Congressional Research Service (CRS).

Curtis, K. J., & Schneider, A. (2011). Understanding the demographic implications of climate change: Estimates of localized population predictions under future scenarios of sea-level rise. *Population and Environment*, *33*(1), 28–54. https://doi.org/10.1007/s11111-011-0136-2

CWPPRA is Still Having a Big Impact. (2017, October 24). Retrieved December 18, 2019, from Restore the Mississippi River Delta website: http://mississippiriverdelta.org/cwppra-still-big-impact/

Davoudi, S., Shaw, K., Haider, L. J., Quinlan, A. E., Peterson, G. D., Wilkinson, C., … Davoudi, S. (2012). Resilience: A Bridging Concept or a Dead End? "Reframing" Resilience: Challenges for Planning Theory and Practice Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan Urban Resilience: What Does it Mean in Planning Practice? Resilience as a Useful Concept for Climate Change Adaptation? The Politics of Resilience for Planning: A Cautionary Note. *Planning Theory & Practice*, *13*(2), 299–333. https://doi.org/10.1080/14649357.2012.677124

Delaware's Sea Level Rise Advisory Committee. (2013, September). *Preparing for Tomorrow's High Tide: Recommendations for Adapting to Sea Level Rise in Delaware*. Retrieved from http://www.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/FinalAdaptationPlansPublished.pdf

Department of Homeland Security (DHS). (2019). The Department of Homeland Security Notice of Funding Opportunity FY 2019 Pre-Disaster Mitigation. Retrieved December 18, 2019, from https://www.fema.gov/media-library-data/1566830100741-668bada6b273e0d310ab7cf2a7f177a6/FY2019_PDM_NOFO_FINALAug2019.pdf

DHS Budget. (2019). Retrieved December 18, 2019, from Department of Homeland Security website: https://www.dhs.gov/dhs-budget

Dinan, T. (2017). *The Financial Soundness and Affordability of the National Flood Insurance Program* (p. 19). Congressional Budget Office (CBO).

DOE 1977-1994 A Summary History. (1994). Retrieved from https://www.energy.gov/sites/prod/files/2017/09/f36/DOE%201977-1994%20A%20Summary%20History_0.pdf

Doherty, M., Klima, K., & Hellmann, J. J. (2016). Climate change in the urban environment: Advancing, measuring and achieving resiliency. *Environmental Science & Policy*, *66*, 310–313. https://doi.org/10.1016/j.envsci.2016.09.001

Ekstrom, J. A., & Moser, S. C. (2014). Identifying and overcoming barriers in urban climate adaptation: Case study findings from the San Francisco Bay Area, California, USA. *Urban Climate*, *9*, 54–74. https://doi.org/10.1016/j.uclim.2014.06.002

Environmental Defense Fund (EDF). (2018). *Financing resilient communities and coastlines*. Retrieved from https://www.edf.org/sites/default/files/documents/EIB_Report_August2018.pdf

Fankhauser, S. (1995). Protection versus Retreat: The Economic Costs of Sea-Level Rise. *Environment and Planning A: Economy and Space*, *27*(2), 299–319. https://doi.org/10.1068/a270299

Federal Register: Establishing a Deductible for FEMA's Public Assistance Program. (2017). Retrieved from https://www.federalregister.gov/documents/2017/01/12/2017-00467/establishing-a-deductible-for-femas-public-assistance-program

FEMA. (2016). *FY 2016 Flood Mitigation Assistance (FMA) Grant Program*.

FEMA. (2017). *Community Rating System Fact Sheet*. Retrieved from https://www.fema.gov/media-library-data/1507029324530-082938e6607d4d9eba4004890dbad39c/NFIP_CRS_Fact_Sheet_2017_508OK.pdf

FEMA. (2019a). *Fiscal Year 2019, Third Quarter* (p. 4).

FEMA. (2019b). *FY 2019 Pre-Disaster Mitigation (PDM) Grant Program* (p. 4).

FEMA. (2019c). Hazard Mitigation Grant Program. Retrieved December 18, 2019, from https://www.fema.gov/hazard-mitigation-grant-program

FEMA. (2019d). Hazus. Retrieved December 18, 2019, from https://www.fema.gov/hazus

FEMA. (2019e). NFIP Transformation and Risk Rating 2.0. Retrieved December 18, 2019, from https://www.fema.gov/nfiptransformation

FEMA. (2019f). Statistics by Calendar Year. Retrieved December 18, 2019, from https://www.fema.gov/statistics-calendar-year

Fenton, A., Gallagher, D., Wright, H., Huq, S., & Nyandiga, C. (2014). Up-scaling finance for community-based adaptation. *Climate and Development*, *6*(4), 388–397. https://doi.org/10.1080/17565529.2014.953902

Fiskel, J. (n.d.). Sustainability and resilience: Toward a systems approach: Sustainability: Science, Practice and Policy: Vol 2, No 2. Retrieved December 18, 2019, from https://www.tandfonline.com/doi/abs/10.1080/15487733.2006.11907980

Flavelle, C. (2017, February 3). FEMA Disaster Deductible Could Survive Trump Deregulation Drive. Retrieved December 18, 2019, from Insurance Journal website: https://www.insurancejournal.com/news/national/2017/02/03/440881.htm

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*, *16*(3), 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002

Fox, K. (2019, July 1). FEMA to offer $250 million for 2020 mitigation grants. Retrieved December 18, 2019, from National Association of Counties website: https://www.naco.org/articles/fema-offer-250-million-2020-mitigation-grants

FUNDING OPTIONS FOR THE TEXAS COASTAL RESILIENCY MASTER PLAN. (2019). Retrieved from https://www.lbb.state.tx.us/Documents/Publications/Staff_Report/2019/4755_Coastal_Infrastructure.pdf

Garfin, G., Jardine, A., Merideth, R., Black, M., & LeRoy, S. (2013). *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*. Retrieved from https://arizona.pure.elsevier.com/en/publications/assessment-of-climate-change-in-the-southwest-united-states-a-rep

Gaynor, P. (n.d.). *Comment Submitted by Peter Gaynor, RI mergency Management Agency*.

Giordano, T. (2012). Adaptive planning for climate resilient long-lived infrastructures. *Utilities Policy*, *23*(C), 80–89.

Goodell, J. (2019, November 4). Jay Inslee Isn't Going Away. Retrieved December 18, 2019, from Rolling Stone website: https://www.rollingstone.com/politics/politics-features/jay-inslee-climate-plan-influence-902461/

Governor Ron DeSantis Announces Dr. Julia Nesheiwat as Florida's First Chief Resilience Officer. (2019, August 1). Retrieved December 18, 2019, from Florida Governor's Office website: https://flgov.com/2019/08/01/governor-ron-desantis-announces-dr-julia-nesheiwat-as-floridas-first-chief-resilience-officer/

Governor's Steering Committee on Climate Change (GSC). (2011). *Connecticut Climate Change Preparedness Plan* (p. 111).

Haimes, Y. (2009). *On the Definition of Resilience in Systems—Haimes—2009—Risk Analysis—Wiley Online Library*. *29*(4). Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1539-6924.2009.01216.x

Hansen, L., Gregg, R., Arroyo, V., Ellsworth, S., Jackson, L., & Snover, A. (2013). *The State of Adaptation in the United States: An Overview*. Retrieved from EcoAdapt website: https://www.cakex.org/documents/state-adaptation-united-states-overview

Hasemyer, D. (2019, November 29). Fossil Fuels on Trial: Where the Major Climate Change Lawsuits Stand Today. Retrieved December 18, 2019, from InsideClimate News website: https://insideclimatenews.org/news/04042018/climate-change-fossil-fuel-company-lawsuits-timeline-exxon-children-california-cities-attorney-general

Hassett, K. A., & Metcalf, G. E. (1995). Energy tax credits and residential conservation investment: Evidence from panel data. *Journal of Public Economics*, *57*(2), 201–217. https://doi.org/10.1016/0047-2727(94)01452-T

Hogue, H. B. (n.d.). *Presidential Reorganization Authority: History, Recent Initiatives, and Options for Congress* (p. 53). Congressional Research Service (CRS).

Holdeman, E. (2019, September 25). BRIC Expanding the Concepts of Federal Pre-Disaster Mitigation. Retrieved December 18, 2019, from Government Technology website: https://www.govtech.com/em/preparedness/BRIC-Expanding-the-Concepts-of-Federal-Pre-Disaster-Mitigation-.html

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, *4*(1), 1–23. https://doi.org/10.1146/annurev.es.04.110173.000245

Horn, D. P., & Webel, B. (2019). *Introduction to the National Flood Insurance Program (NFIP)* (p. 31). Congressional Research Service (CRS).

Hsiang, S., Kopp, R., Jina, A., Rising, J., Delgado, M., Mohan, S., … Houser, T. (2017). Estimating economic damage from climate change in the United States. *Science*, *356*(6345), 1362–1369. doi: 10.1126/science.aal4369

Huber, D. (2012). *FIXING A BROKEN NATIONAL FLOOD INSURANCE PROGRAM: RISKS AND POTENTIAL REFORMS* (p. 14). Center for Climate and Energy Solutions.

HUD. (2019a). National Disaster Resilience. Retrieved December 18, 2019, from https://www.hudexchange.info/programs/cdbg-dr/resilient-recovery/

HUD. (2019b). Rebuild by Design. Retrieved December 18, 2019, from https://www.hud.gov/sandyrebuilding/rebuildbydesign

Hughes, S. (2015). A meta-analysis of urban climate change adaptation planning in the U.S. *Urban Climate*, *14*, 17–29. https://doi.org/10.1016/j.uclim.2015.06.003

Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. (2018). U.S. Global Change Research Program.

Insurance Information Institute (III). (2019, November). Facts + Statistics: Flood insurance. Retrieved December 18, 2019, from https://www.iii.org/fact-statistic/facts-statistics-flood-insurance

Internal Revenue Service (IRS). (2017). Get Credit for Making a Home Energy Efficient. Retrieved December 18, 2019, from https://www.irs.gov/newsroom/get-credit-for-making-a-home-energy-efficient

Jha, A. K., Miner, T. W., & Stanton-Geddes, Z. (2013). *Building Urban Resilience: Principles, Tools, and Practice*. Retrieved from https://ideas.repec.org/b/wbk/wbpubs/13109.html

Keenan, J. M. (2018). *Climate Adaptation Finance and Investment in California* (1st ed.). https://doi.org/10.4324/9780429398759

Kline, C. (2017). *Funding Coastal Protection & Restoration*. Retrieved from http://www.covalentlogic.com/assets/docs/AmWet/102516-AWF-CPRA-Roundtables-ChipKline.pdf

Knutson, T. R., Sirutis, J. J., Vecchi, G. A., Garner, S., Zhao, M., Kim, H.-S., … Villarini, G. (2013). Dynamical Downscaling Projections of Twenty-First-Century Atlantic Hurricane Activity: CMIP3 and CMIP5 Model-Based Scenarios. *Journal of Climate*, *26*(17), 6591–6617. https://doi.org/10.1175/JCLI-D-12-00539.1

Kopp, R. E., Horton, R. M., Little, C. M., Mitrovica, J. X., Oppenheimer, M., Rasmussen, D. J., … Tebaldi, C. (2014). Probabilistic 21st and 22nd century sea-level projections at

a global network of tide-gauge sites. *Earth's Future*, *2*(8), 383–406. https://doi.org/10.1002/2014EF000239

Kosar, K. (2017, March 14). Why Trump's government overhaul won't work. Retrieved December 18, 2019, from Politico website: https://www.politico.com/agenda/story/2017/03/trump-government-overhaul-fail-without-congress-000362

Lackstrom, K., Dow, K., Haywood, B., Brennan, A., Kettle, N., & Brosius, A. (2012). *Engaging Climate-Sensitive Sectors in the Carolinas* (p. 201). Carolinas Integrated Sciences and Assessments (CISA), University of South Carolina.

Lightbody, L. (2019, October 22). Virginia's Flood Mitigation Program Needs Funding. Retrieved December 18, 2019, from Pew Charitable Trusts website: https://pew.org/2p7Kf0q

Lipiec, E., & Crafton, R. E. (2019). *The Coastal Barrier Resources Act (CBRA)* (p. 2). Congressional Research Service (CRS).

Lopez, G. (2015, August 23). 7 facts about Hurricane Katrina that show just how incompetent the government response was. Retrieved December 18, 2019, from Vox website: https://www.vox.com/2015/8/23/9191907/hurricane-katrina

Massachusetts State Hazard Mitigation and Climate Adaptation Plan. (2018). Retrieved from https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

Matyas, D., & Pelling, M. (2015). Positioning resilience for 2015: The role of resistance, incremental adjustment and transformation in disaster risk management policy. *Disasters*, *39 Suppl 1*, S1-18. https://doi.org/10.1111/disa.12107

Mayunga, J. S. (2007). *Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach*. 16.

McIntosh, N., & Cone, J. (n.d.). *Responding to the Effects of Coastal Climate Change: Results of a National Sea Grant Survey* (p. 24).

Mead, M. (2016, March 10). *Comment Submitted by Dalena Hill, Office of the Governor State of Wyoming*.

Meade, N., Baker, T., & Brosnan, T. (n.d.). *Introduction to Natural Resource Damage Assessment*. 69.

Meerow, ara, Newell, J. P., & Stults, M. (2015). *Defining urban resilience: A review*.

Mendelsohn, R. (2000). Efficient Adaptation to Climate Change. *Climatic Change*, *45*(3), 583–600. https://doi.org/10.1023/A:1005507810350

Mitchell, A. (2013). *Risk and Resilience: From Good Idea to Good Practice*. Retrieved from Organisation for Economic Co-operation and Development website: http://www.oecd.org/dac/conflict-fragility-resilience/docs/Resilience_and_Risk_Good_ideas_Good_practice.pdf

Mitchell, T., Aalst, M. V., & Villanueva, P. S. (2010). *Assessing Progress on Integrating Disaster Risk Reduction and Climate Change Adaptation in Development Processes*.

Morsch, A., & Bartlett, R. (2011). *State Strategies to Plan for and Adapt to Climate Change* (p. 5). Duke University Nicholas Institute.

Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences*, *107*(51), 22026–22031. https://doi.org/10.1073/pnas.1007887107

National Coastal Wetlands Conservation Grant Program. (2019). Retrieved December 18, 2019, from U.S. Fish and Wildlife Service website: https://www.fws.gov/coastal/CoastalGrants/index.html

National Fish and Wildlife Foundation (NFWF). (2018a). *National Coastal Resilience 2018 Grant Slate* (p. 7).

National Fish and Wildlife Foundation (NFWF). (2018b, April 20). Eight years after Deepwater Horizon oil spill, conservation along the Gulf of Mexico advances at an historic scale. Retrieved December 18, 2019, from https://www.nfwf.org/whoweare/mediacenter/pr/Pages/eight-years-after-deepwater-horizon-oil-spill-conservation-along-the-gulf-of-mexico-advances-at-an-historic-scale-2018-0418.aspx

National Fish and Wildlife Foundation (NFWF). (2019). National Coastal Resilience Fund. Retrieved December 18, 2019, from https://www.nfwf.org/coastalresilience/Pages/home.aspx

National Institute of Building Sciences (NIBS). (2018). *Natural Hazard Mitigation Saves: 2018 Interim Report*. Retrieved from https://cdn.ymaws.com/www.nibs.org/resource/resmgr/mmc/NIBS_MSv2-2018_Interim-Repor.pdf

National Rural Electric Cooperative Association. (2016, March 21). *Final NRECA Deductible Comments*.

Neubert, M. G., & Caswell, H. (1997). ALTERNATIVES TO RESILIENCE FOR MEASURING THE RESPONSES OF ECOLOGICAL SYSTEMS TO PERTURBATIONS. *Ecology*, *78*(3), 653–665. https://doi.org/10.1890/0012-9658(1997)078[0653:ATRFMT]2.0.CO;2

New Study Finds 117,000 Louisiana Homes Worth $13 Billion will be at Risk from Tidal Flooding. (2018, June 18). Retrieved December 18, 2019, from Union of Concerned Scientists website: https://www.ucsusa.org/about/news/117000-louisiana-homes-risk-tidal-flooding

New York State Energy Research and Development Authority (NYSERDA). (2011). *Responding to Climate Change in New York State*.

Nixon, J., & Hutchinson, A. (2016, March 21). *Comment Submitted by Justin Stevens, National Governors Association*.

Nordgren, J., Stults, M., & Meerow, S. (2016). Supporting local climate change adaptation: Where we are and where we need to go. *Environmental Science and Policy*, *66*, 344–352. https://doi.org/10.1016/j.envsci.2016.05.006

Northam, R. *Executive Order 24: Increasing Virginia's Resilience To Sea Level Rise And Natural Hazards*. , (2018).

Northam, R. *E.O. 45: Virginia Flood Risk Management Standard*. , (2019).

Obama, B. *Executive Order – Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*. , (2015).

Office of Governor Gina M. Raimondo. (2018). *Resilient Rhody* (p. 44).

Office of Management and Budget. (2016). *STANDARDS AND FINANCE TO SUPPORT COMMUNITY RESILIENCE*. Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/omb/reports/omb_resilience_finance_report.pdf

Our Land and Water: A Regional Approach to Adaptation. (2019, April). Retrieved from https://s3.amazonaws.com/lasafe/Final+Adaptation+Strategies/Regional+Adaptation+Strategy.pdf

Pendall, R., Foster, K. A., & Cowell, M. (2010). Resilience and regions: Building understanding of the metaphor. *Cambridge Journal of Regions, Economy and Society*, *3*(1), 71–84. https://doi.org/10.1093/cjres/rsp028

Pervin, M., Sultana, S., Phirum, A., Camara, I. F., Nzau, V. M., Phonnasane, V., … Anderson, S. (2013). *A framework for mainstreaming climate resilience into development planning* (p. 36). International Institute for Environment and Development.

Pew Charitable Trusts. (2016). *1 in 4 High-risk areas have at least a 1 in 4 chance of flooding during a 30-year mortgage.*

Pielke, R. A., Gratz, J., Landsea, C. W., Collins, D., Saunders, M. A., & Musulin, R. (2008). Normalized Hurricane Damage in the United States: 1900–2005. *Natural Hazards Review*, *9*(1), 29–42. https://doi.org/10.1061/(ASCE)1527-6988(2008)9:1(29)

Quinlan, A. E., Berbés-Blázquez, M., Haider, L. J., & Peterson, G. D. (2016). Measuring and assessing resilience: Broadening understanding through multiple disciplinary

perspectives. *Journal of Applied Ecology*, *53*(3), 677–687. https://doi.org/10.1111/1365-2664.12550

RAND Corporation. (2012). *Coastal Louisiana risk assessment model: Technical description and 2012 coastal master plan analysis results*. Santa Monica, Calif: Rand Corp.

Reed, T. *Disaster Savings and Resilient Construction Act of 2018*. , Pub. L. No. H.R. 6841 (2018).

Ribicoff, A. A. *An Act to establish a Department of Energy in the executive branch by the reorganization of energy functions within the Federal Government in order to secure effective management to assure a coordinated national energy policy, and for other purposes.* , (1977).

Robert T. Sta ord Disaster Relief and Emergency Assistance Act. , Pub. L. No. 93–288 (1988).

Samuels, A. (2019, November 6). Texas voters approve state income tax ban, most other constitutional amendments. Retrieved December 18, 2019, from The Texas Tribune website: https://www.texastribune.org/2019/11/05/texas-constitutional-amendments-uniform-election-results-2019/

Satterthwaite, D. (2013). The political underpinnings of cities' accumulated resilience to climate change. *Environment and Urbanization*. Retrieved from https://journals.sagepub.com/doi/full/10.1177/0956247813500902

Scata, J. (2017, October 12). FEMA's Outdated and Backward-Looking Flood Maps. Retrieved December 18, 2019, from Natural Resources Defense Council website: https://www.nrdc.org/experts/joel-scata/femas-outdated-and-backward-looking-flood-maps

Schipper, L., & Langston, L. (2015). *A comparative overview of resilience measurement frameworks: Analysing indicators and approaches*. Retrieved from Overseas Development Institute website: https://www.odi.org/publications/9632-comparative-overview-resilience-measurement-frameworks-analysing-indicators-and-approaches

Shi, L., Chu, E., Anguelovski, I., Aylett, A., Debats, J., Goh, K., … VanDeveer, S. D. (2016). Roadmap towards justice in urban climate adaptation research. *Nature Climate Change*, *6*(2), 131–137. https://doi.org/10.1038/nclimate2841

Shoreline Change Advisory Committee. (2010, April). *Adapting to Shoreline Change: A Foundation for Improved Management and Planning in South Carolina*. Retrieved from https://scdhec.gov/sites/default/files/Library/CR-009823.pdf

Shoreline Preservation Task Force. (2013). *REPORT OF THE SHORELINE PRESERVATION TASK FORCE* (p. 11).

Silvis, V. G. (2017). Flooding by Design: A Look at the National Flood Insurance Program. *Risk, Hazards & Crisis in Public Policy*, *9*(1), 82–99. https://doi.org/10.1002/rhc3.12131

Smith, A. (2019). 2018's Billion Dollar Disasters in Context. Retrieved December 18, 2019, from National Oceanic and Atmospheric Administration website:

https://www.climate.gov/news-features/blogs/beyond-data/2018s-billion-dollar-disasters-context

Spezio, T. S. (2018). *Slick Policy: Environmental and Science Policy in the Aftermath of the Santa Barbara Oil Spill*. University of Pittsburgh Press.

State and Local Adaptation Plans. (2019). Retrieved December 18, 2019, from Georgetown Climate Center website: https://www.georgetownclimate.org/adaptation/plans.html

Steyer, T. (2019). Framework for a Justice-Centered Climate Plan—Tom Steyer. Retrieved December 18, 2019, from Tom Steyer 2020 website: https://www.tomsteyer.com/climate-plan-framework/

Summers, J. K., Harwell, L. C., Smith, L. M., & Buck, K. D. (2018). Measuring Community Resilience to Natural Hazards: The Natural Hazard Resilience Screening Index (NaHRSI)—Development and Application to the United States. *GeoHealth*, *2*(12), 372–394. https://doi.org/10.1029/2018GH000160

Surjan, A., Sharma, A., & Shaw, R. (2011). Understanding urban resilience. *Climate and Disaster Resilience in Cities*, 17–45. https://doi.org/10.1108/S2040-7262(2011)0000006008

Sussman, F., Krishnan, N., Maher, K., Miller, R., Mack, C., Stewart, P., … Perkins, B. (2014). Climate change adaptation cost in the US: What do we know? *Climate Policy*, *14*(2), 242–282. https://doi.org/10.1080/14693062.2013.777604

Taşan-Kok, T., Stead, D., & Lu, P. (2013). Conceptual Overview of Resilience: History and Context. In *GeoJournal Library*. *Resilience Thinking in Urban Planning* (pp. 39–51). https://doi.org/10.1007/978-94-007-5476-8_3

Texas Coastal Resiliency Master Plan. (2019). Retrieved from https://coastalstudy.texas.gov/resources/files/2019-coastal-master-plan.pdf

The Cabinet. (2019). Retrieved December 18, 2019, from Office of the Governor website: http://gov.louisiana.gov/page/the-cabinet

Thompson, B. (2016, March 29). *Comment Submitted by Bernie G. Thompson, U.S. House of Representatives, Committee on Homeland Security*.

Timmerman, P. (Peter). (1981). *Vulnerability, resilience and the collapse of society: A review of models and possible climatic applications*. Retrieved from http://archive.org/details/vulnerabilityres00timm

Transportation and Infrastructure Committee. (2017). *H. Rept. 115-107—FEMA ACCOUNTABILITY, MODERNIZATION AND TRANSPARENCY ACT OF 2017* [Legislation]. Retrieved from https://www.congress.gov/congressional-report/115th-congress/house-report/107/1

Two Storm Panel. (n.d.). *REPORT OF THE TWO STORM PANEL* (p. 42).

Tyler, S., & Moench, M. (2012). A framework for urban climate resilience. *Climate and Development*, *4*(4), 311–326. https://doi.org/10.1080/17565529.2012.745389

Union of Concerned Scientists (UCS). (2018). *Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate*. Retrieved from https://www.ucsusa.org/sites/default/files/attach/2018/06/underwater-analysis-full-report.pdf

U.S. Climate Resilience Toolkit. (2019). Funding Opportunities. Retrieved December 18, 2019, from https://toolkit.climate.gov/content/funding-opportunities

U.S. Department of the Treasury (USDT). (2019). RESTORE Act. Retrieved December 18, 2019, from https://home.treasury.gov/policy-issues/financial-markets-financial-institutions-and-fiscal-service/restore-act

US EPA. (1990). EPA: A Retrospective, 1970-1990 [Overviews and Factsheets]. Retrieved December 18, 2019, from epa-retrospective-1970-1990.html

US EPA. (2016, July 1). Climate Change Indicators: Coastal Flooding [Reports and Assessments]. Retrieved December 18, 2019, from US EPA website: https://www.epa.gov/climate-indicators/climate-change-indicators-coastal-flooding

U.S. Government Accountability Office (GAO). (2018). *Climate Change: Analysis of Reported Federal Funding*. Retrieved from https://www.gao.gov/assets/700/691572.pdf

Walker, B., & Salt, D. (2012). *Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function*. https://doi.org/10.5822/978-1-61091-231-0

Warmbrodt, Z. (2019a, March 18). Trump administration to put new price tag on flood insurance, risking backlash. Retrieved December 18, 2019, from Politico website: https://www.politico.com/story/2019/03/18/trump-administration-flood-insurance-1277205

Warmbrodt, Z. (2019b, November 7). FEMA postpones flood insurance rate revamp amid backlash. Retrieved December 18, 2019, from Politico website: https://www.politico.com/news/2019/11/07/fema-postpones-flood-insurance-rate-revamp-amid-backlash-067505

Waxman, L. (2017). *NATIONAL CONFERENCE OF STATE LEGISLATURES NATIONAL LEAGUE OF CITIES THE UNITED STATES CONFERENCE OF MAYORS Comment on the Proposed Disaster Deductible*.

Wheeler, S. (2008). State and Municipal Climate Change Plans: The First Generation. *American Planning Association*, *74*(4). Retrieved from https://www.tandfonline.com/doi/abs/10.1080/01944360802377973

Winderl, T. (2014). *Disaster resilience measurements: Stocktaking of ongoing efforts in developing systems for measuring resilience | PreventionWeb.net*. Retrieved from United Nations Development Programme website: https://www.preventionweb.net/publications/view/37916

Wright, R. *The Economic and Health Consequences of Climate Change*. , § Committee on Ways and Means (2019).

Yohe, G., Neumann, J., Marshall, P., & Ameden, H. (1996). The economic cost of greenhouse-induced sea-level rise for developed property in the United States. *Climatic Change*, *32*(4), 387–410. https://doi.org/10.1007/BF00140353

Young, B. *DEPARTMENT OF DEFENSE, EMERGENCY SUPPLEMENTAL APPROPRIATIONS TO ADDRESS HURRICANES IN THE GULF OF MEXICO, AND PANDEMIC INFLUENZA ACT, 2006*. , Pub. L. No. 109–148 (2005).